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Godfrey Hammond

SEPTEMBER 1946

Cover Painting by RAY PIOCH

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Published monthly at 353 Fourth Avenue, New York 10, N. Y. by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Stephen P. Glennon, B. Ray Keefer, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A. Copyright, 1946, by Popular Science Publishing Co., Inc. All rights reserved in the United States, Great Britain, and in all countries participating in the International Copyright Convention and Pan-American Copyright Convention. Yearly subscriptions to United States and its possessions, $2.50; Canada, $3.00; foreign countries, excepting Canada, $3.50. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new addresses.

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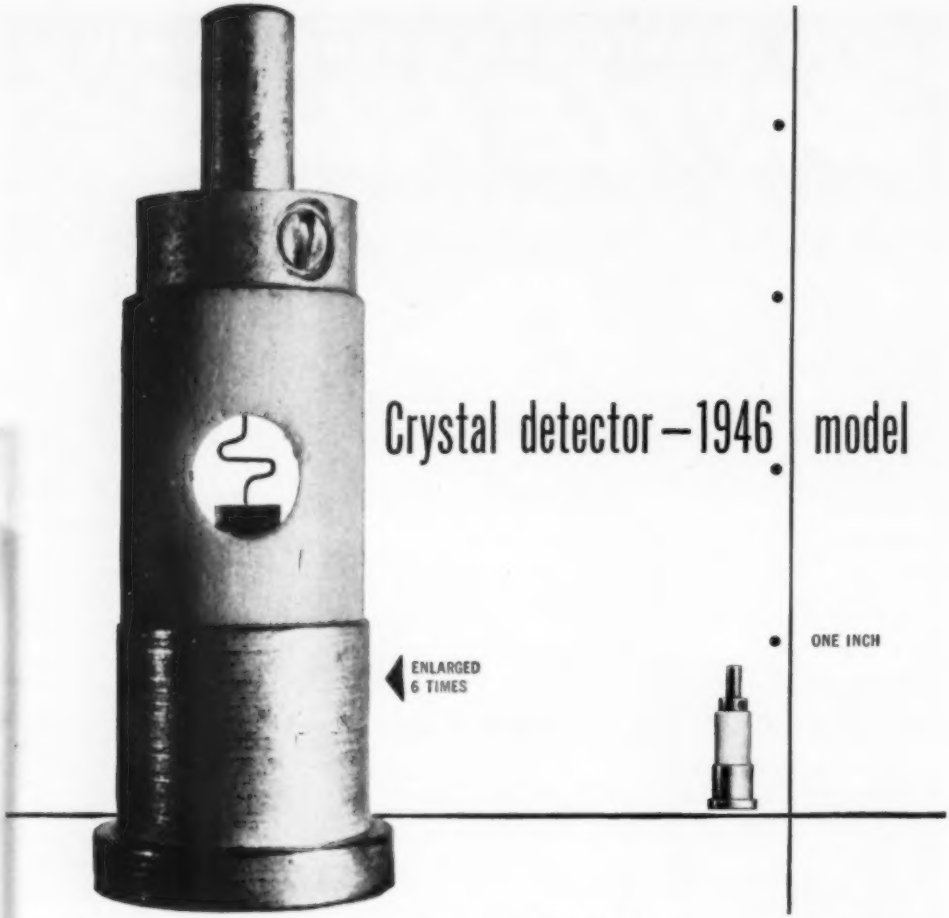

Remember the crystal detector in the first radios—hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories scientist thought back to the old crystal.

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WHO won the war is already an old argument. But certainly science, forging the final weapon, stopped the war. Yet, a year later, science is still literally a prisoner of war.

When science was mobilized, the military services quite properly invaded the universities. They had to halt the basic research. They put the men and machines of science to work on the pressing necessities that mothered radar, sonar, loran, and a thousand other urgent applications of that basic research. The scientists did their work well, including the actual manufacture of such things as the rockets and the trained atoms.

Now, the military minds propose to maintain their command of the scientists by subsidizing pure research. Traditionally, the universities have been the birthplace of pure science. The directions of science for its own sake of knowing have been determined only by the resources of the great laboratories and the zeal of the seekers.

Now comes the brass, bearing cash, to the universities. Already, contracts have been let, researches have been begun. But what will it mean to science if the Navy is the paymaster? What will it mean to all of us if the Army calls the tune? How can science function honestly, let alone efficiently, under military security?

Certainly, we do not mean that this kind of work should not be undertaken by the universities. Certainly more, not less, money should be spent for science as science. But we strongly urge that public money for scientific research be spent directly by the people through qualified civilians, and not detoured through the military, which has its own traditions to preserve, and which would keep science in uniform.

Perry Gilkeson

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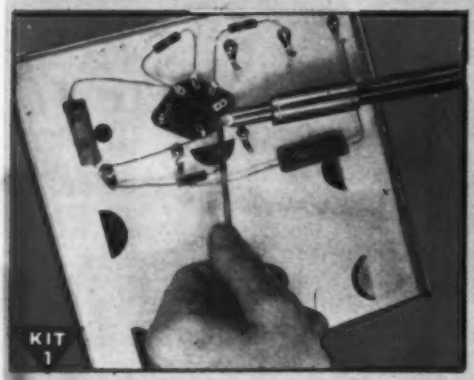
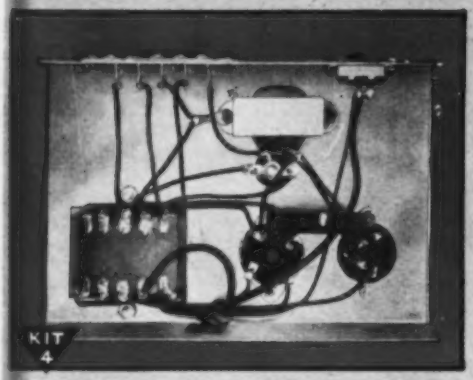
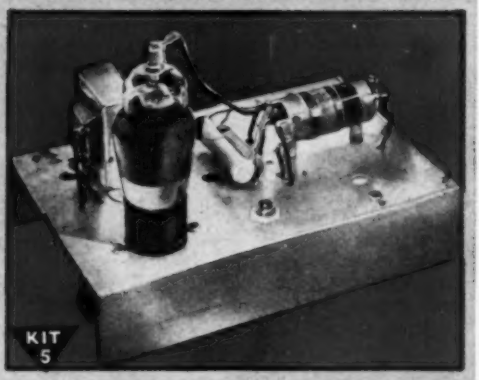


I send you Soldering Equipment and Radio parts; show you how to do Radio soldering; how to mount and connect Radio parts; give you practical experience.

Early in my course I show you how to build this N.R.I. Tester with parts I send. It soon helps you fix neighborhood Radios and earn EXTRA money in spare time.



You get parts to build this Vacuum Tube Power Pack; make changes which give you experience with packs of many kinds; learn to correct power pack troubles.



Building this A. M. Signal Generator gives you more valuable experience. It provides amplitude-modulated signals for many tests and experiments.

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"I am now operating a radio shop for myself and own all my equipment. Right now repairing radios pays me an average of about $250 a month."—J. M. SCRIVENER, JR., Aberdeen, Miss.

Fixing Radios Profitable Hobby

"I am doing radio work in my spare time, and find it a profitable hobby. My extra earnings run about $10 a week. I certainly am glad I took your N.R.I. course." — FERDINAND ZIRBEL, Chaseley, North Dakota.

Chief Engineer, Station KWLM

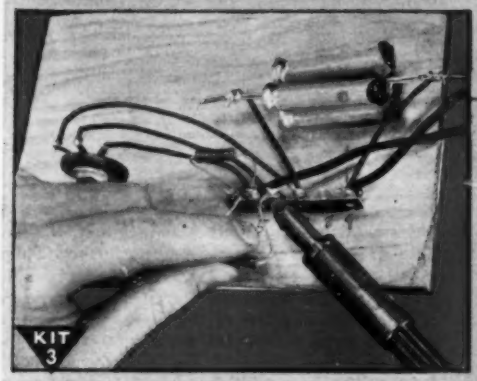
"Am now Chief Engineer of Station KWLM and in charge of maintenance of Police Station KRIN, County Highway Dept. Also have own business."—LLOYD V. STENBERG, 616 Litchfield Ave., W., Willmar, Minn.

Still Climbing in Aircraft Radio

"I am still climbing as a result of my N.R.I. training. I now do aircraft radio work at Greenwood Army Air Field, and operate a radio shop in my spare time."—JAMES L. BOYETTE, Box 318, Greenwood, Miss.

by Practicing in Spare Time

I Send You 6 Big Kits of Radio Parts



You get parts to build Radio Circuits; then test them; see how they work; learn how to design special circuits; how to locate and repair circuit defects.

You build this Superheterodyne Receiver which brings in local and distant stations—and gives you more experience to help you win success in Radio.

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Many Beginners Soon Make Extra Money in Spare Time while Learning

The day you enroll I start sending EXTRA MONEY JOB SHEETS that show how to make EXTRA money fixing neighbors' Radios in spare time while still learning! It's probably easier to get started now than ever before, because the Radio Repair Business is booming. Trained Radio Technicians also find profitable opportunities in Police, Aviation, Marine Radio, Broadcasting, Radio Manufacturing, Public Address work. Think of even *greater* opportunities as Television, FM, and Electronic devices become available to the public! Send for FREE books now!

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The Secret of MENTAL CREATING

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All things begin with thought—it is what follows that may take your life out of the class of those who hope and dream. Thought energy, like anything else, can be dissipated—or it can be made to produce actual effects. *If you know how to place your thoughts* you can stimulate the creative processes within your mind—through them you can assemble things and conditions of your world into a happy life of accomplishment. *Mental creating* does not depend upon a magical process. It consists of *knowing how* to marshal your thoughts into a power that draws, compels and organizes your experiences into a worth-while design of living.

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"Dynamic Tension!" That's the ticket! The identical natural method that I myself developed to change my body from the scrawny, skinny-chested weakling I was at 17 to my present super-man physique! Thousands of other fellows are becoming marvelous physical specimens—my way. I give you no gadgets or contraptions to fool with. When you have learned to develop your Strength through *"Dynamic Tension"* you can laugh at artificial muscle-makers. You simply utilize the DORMANT muscle-power in your own God-given body—watch it increase and multiply double-quick into real solid MUSCLE.

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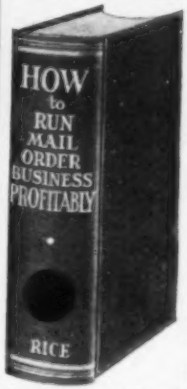

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LETTERS

"Shooting" Stars a Century Ago

Sir:

In the article, "When Suns Explode," (PSM, July '46, p. 108) . . . you stated that "photography was young (in 1866) and pictures of stars were not possible." Actually, the first application of photography to astronomy was in 1840 when Dr. John William Draper of New York obtained a daguerreotype of the moon. The first successful star picture was taken in 1850 with the 15-inch telescope at the Harvard College Observatory . . .

THOMAS W. DONNELLY
Washington, D. C.

Dr. Donald H. Menzel, of Harvard, who wrote "When Suns Explode," admits the accuracy of Reader Donnelly's facts and was aware of them. His thought, in ignoring the pioneer sky photographs, was that their pictures were of insignificant scientific value; they were stunts and not a well-developed process widely applied for recording the status of the heavens.

Where "New Ideas" Come From

Sir:

Please send me information concerning your regular monthly feature, "New Ideas from the Inventors." Does *Popular Science Monthly* buy these ideas or do the inventors have them patented and then submit them?

TERRY CLARK, JR.
Philadelphia, Pa.

Neither. The U. S. Patent Office publishes periodic announcements of the latest patents it has granted. PSM selects those ideas that seem most likely to interest its readers and does a reporting job on them.

Happy to Oblige

Sir:

I have been invited by the Physical Society of London to deliver a paper at the symposium on low-temperature research at

INVENTORS

The Rules of Practice of U. S. Patent Office advises—unless the inventor is qualified to handle such matters—that he employ the services of a competent Patent Attorney in the preparation of his Patent Application. We are Registered Patent Attorneys fully qualified to represent you at the Patent Office. Our long and varied experience in patent practice, we believe, enables us readily to understand inventors' disclosures, to advise what is probably patentable, after conducting preliminary patentability investigation of prior U. S. patents, and to draw your specifications and claims in such manner as to present clearly the novel features.

Patent Laws Favor the Inventor Who Acts Promptly

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the University of Cambridge. They want a completed manuscript, together with prints, so that the paper may be published. . . .

May I have permission from *Popular Science Monthly* to reproduce three photographs for publication with this paper in the proceedings of the Physical Society of London: (1) the view showing the top of the bolometer, (2) the scanning mirror, and (3) the arrangement of gears and rheostats used in driving the scanning mirror . . .

DONALD H. ANDREWS

Johns Hopkins University
Baltimore, Md.

PSM, always happy to serve scientists in this way, was especially glad to send the requested prints to Dr. Andrews, inventor of the superconducting bolometer, who so effectively assisted Associate Editor Mann in the preparation of his article about it for the July issue.

"Mouth of Hell"

Sir:

Rummaging through my old issues of PSM I came to a matter of particular interest to me on page 108 of the October 1944 issue. The article was entitled, "Closing the Mouth of Hell," and explained how Mexican authorities closed a hole in the earth, 475 feet deep, because of the increasing number of tragedies occurring there.

The National Speleological Society, of which I am a member, is a scientific organization of men and women devoted to the study of caves and caverns.

As long as there is the faintest possibility of there being a passage at the bottom of this shaft, or a possibility of remains of Aztec human sacrifices, etc., we intend to go down and see it. We are sadly lacking in information, however. Is the hole in a limestone area? Is it an earthquake fissure or a natural cavernous hole? Can we get in by digging under the sealed-over entrance without harming it? How do you get to the place?

R. L. TANNER

Arlington, Va.

Speleologist Tanner has been referred to a fellow enthusiast for the underground, Prof. Augustin Aragon Leiva, of Mexico City, who is an authority on the "Mouth of Hell."

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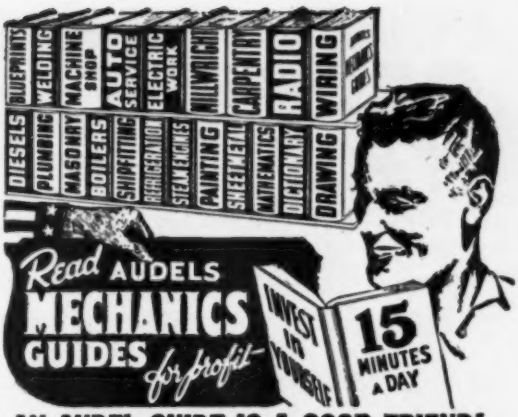

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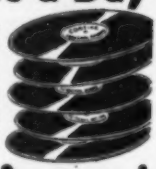

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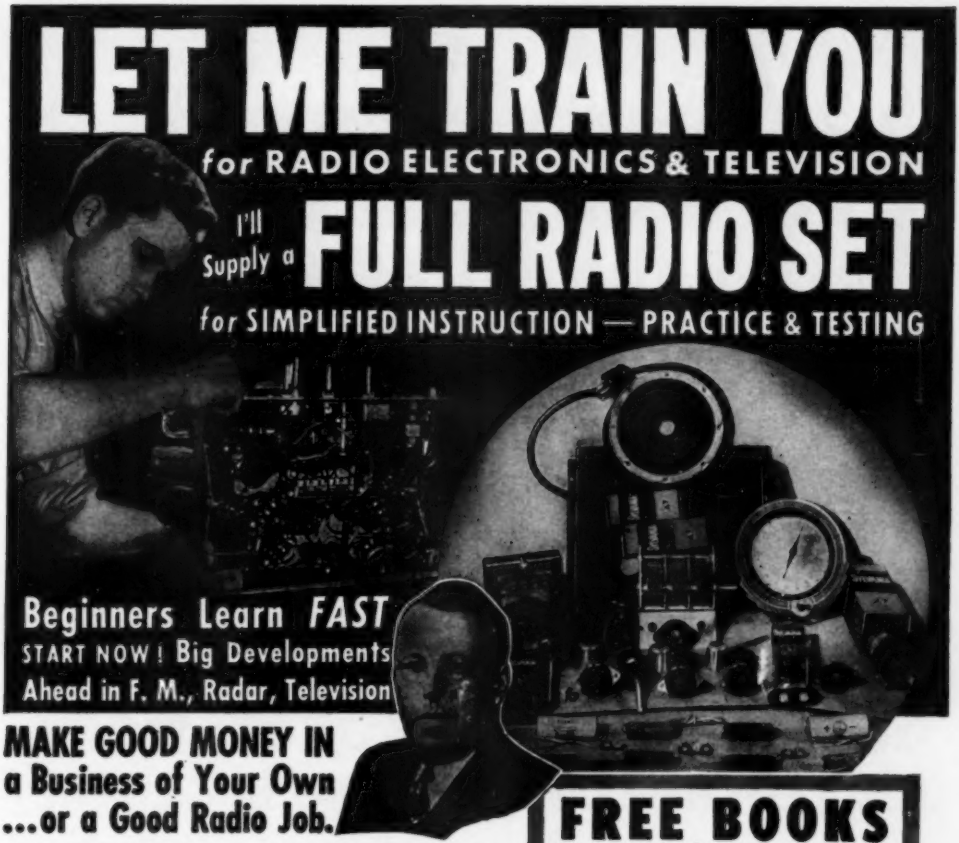

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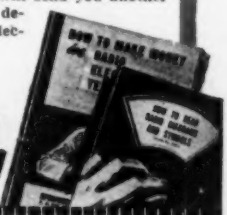

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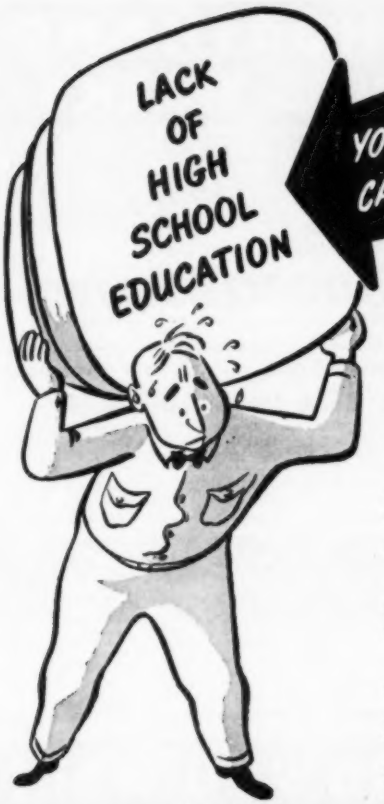

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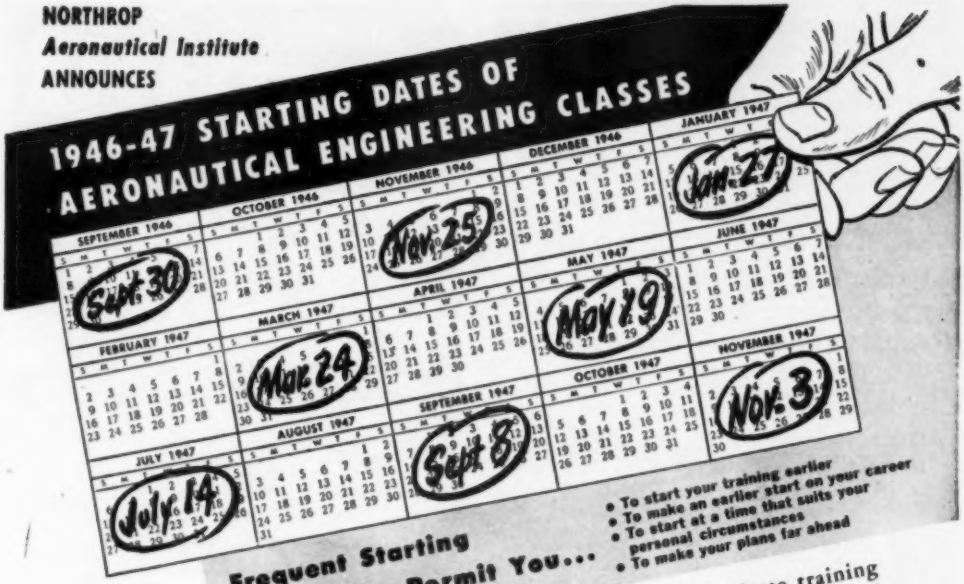

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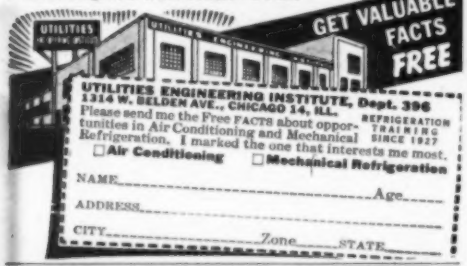

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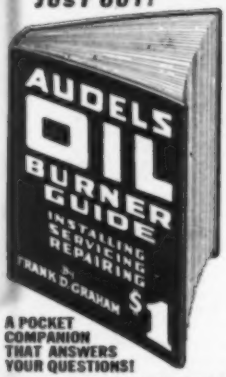

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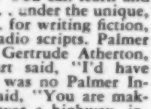

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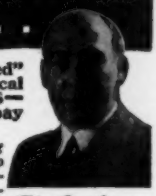

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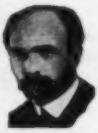

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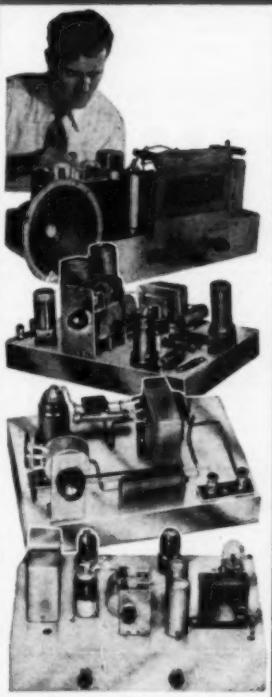

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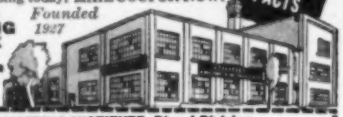

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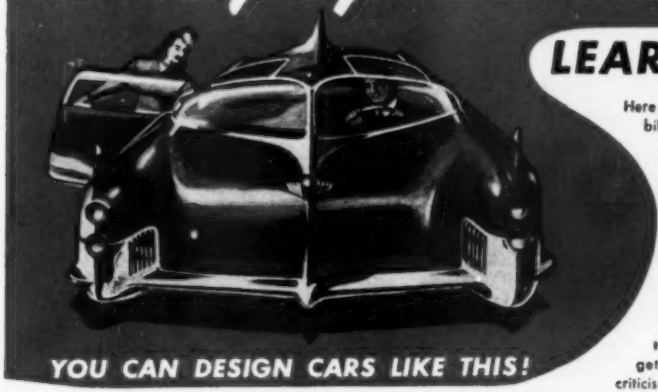

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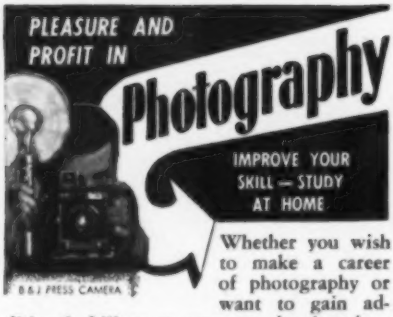

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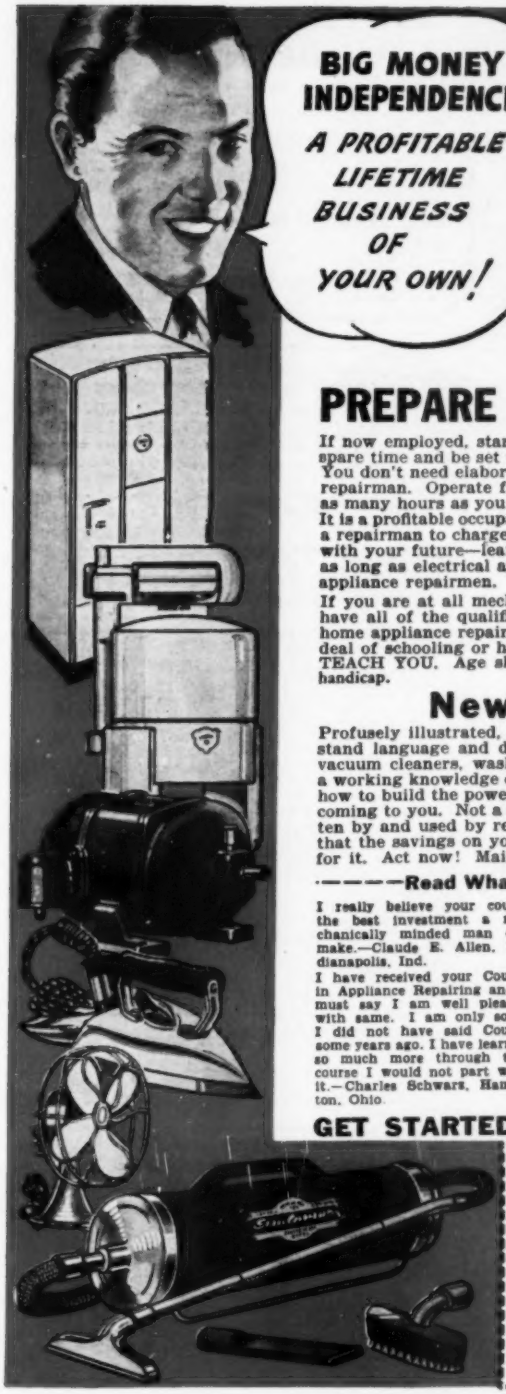

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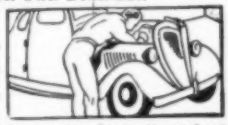

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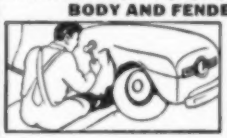

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Heavy canvas. Button fastener.
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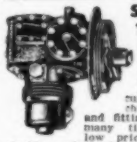

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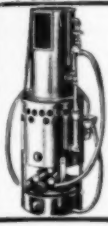

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The new rate increase will not go into effect October, 1946 as previously announced. The change in rate will become effective January 1, 1947.

POPULAR SCIENCE MONTHLY—351 FOURTH AVE.—NEW YORK CITY 10

1 ADVICE

DRUNKENNESS Is a disease which responds to treatment. Medical skill plus human sympathy prove successful with liquor and drug cases. 60 years experience. Write for free booklet. P. S. Nelson, The Keeley Institute, Dwight, Ill.

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BUSINESS Opportunities Galore—Information booklet 25c. Bi-Monthly for Year $1.00. Parcell, 2701 Main, Elkhart, Indiana.

WORRIED, Troubled, Afraid? Get help now! Bring your problem to The Counselor, Confidential, Reliable. Fee $1.00. P.O. Box 503, Dept. 2, Chicago 90, Ill.

"FREE information!" Locates thousands scarce bargain merchandise. Druggist, Box 1279-S, Joliet, Ill.

DON'T change jobs! Don't marry! Thousand word handwriting analysis will guide you. Write liberally. $3.00. H. Bennett, 434 W. 120th St., New York 27.

How to own a profitable business all or part time. Details 10c (refundable). Box 12T, Oaklandon, Ind.

HEAL The sick, eliminate disease, fulfill every need through the spoken word. "Vitascience" tells how. Free details. Cedric S. Moore, 1313 South Union, Kokomo, Indiana.

$25 WEEKLY working two hours daily with Textiles, Plastics, Costume Jewelry, Dolls. Complete plans 25c. Myra Allan Creations, 1005 Market, Philadelphia 7, Pa.

2 ADVERTISING

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ADVERTISE Profitably: $20.00 reaches 5,000,000 Sunday newspaper readers with 24-word ad. Newspaper, magazine, mailing-list ratebook free. Chicago Advertising Agency, 20-PS West Jackson, Chicago 4.

"HOW To Write Advertising" absolutely free! Dudley Bunn, 126-PS Lexington Ave., New York 16.

24 WORDS in 64 Weeklies $4.96. J. Darnell, 730 Hays, Jackson, Tenn.

TRADEMARKS! Designed for your company or products by famous artist. $2.00. Wrogers, 2333 Dwight, Berkeley, California.

SPEEDY mailing, 500,000 classified names and addresses on stickers. Classified Personal Adv., 7 Chestnut St., Waterloo, N. Y.

SERVICE Station driveway "Service Signals" again available. Free literature. Territories still open. Knipp Specialty, 1207 Orizaba, Long Beach 4, Cal.

MAKE more money. Start Christmas Gift sales now. Opportunities unlimited. Materials furnished. Write for Free book of confidential commissions on all magazines. McGregor Magazine Agency, Dept. 31, Mount Morris, Ill.

ADVERTISING sales Literature planned, written, 25 years' experience. L. S. VanDenburgh, Box 201, Newark 1, N. J.

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"500 MILE" Indianapolis Automobile Racing History Book, just printed. Complete history detailed year by year results every Indianapolis race since 1909. 320 large pages, over 2,000 illustrations, drawings, photographs describe foreign, American racing automobiles. Photographs world's famous drivers. View in your arm chair every mile of every event at 10c a race average cost. Complete book Postpaid $3.50 De Luxe Edition bound attractive red Du Pont Fabrikoid $5.00. Limited number available, hurry! Clymer, Dept. B92, 2125 W. Pico, Los Angeles 6, Calif.

5 AGENTS WANTED

GOOD Paying Business Silvering mirrors, plating autoparts, reflectors, bicycles, bathroom fixtures, etc., by late method. No tanks or shop required, outfit furnished. Free Booklet. Gunmetal Co., Ave. G, Decatur, Illinois.

LICK After-war layoffs; Start own business; home, office. Booklet describing "Collection of 127 Tester Plans" free. Elite Co., 220 Grand St., New York.

FREE Water and our concentrates makes flavors, lotions, shampoos, 72 products, labels, bottles furnished. Qualco, F-20030 Russell, Detroit.

FREE! Latest issue Opportunity Magazine, Salesman's Guide. Inspiring, constructive. Shows how to earn money selling for others or in your own business. Hundreds postwar opportunities. Send name and describe what you have sold or are selling. Illustrated copy sent Free. Opportunity Magazine, 620 N. Michigan, Dept. 18, Chicago 11, Ill.

MAGIC cleaner and laundry soap deal. Hotter than a firecracker. Big profits. Sample Free. Uco, 5007 Irving Park, Chicago.

JUST Out! History of World II. Huge volume. Popular price. Authentic text. Official Photographs. Big profits. Riverside Book Co., Iowa Falls, Ia.

START Your Own Business on our capital. Always your own boss. Hundreds average $6,000 to $25,000 annual sales year after year. We supply stocks, equipment on credit. 200 home necessities. Selling experience unnecessary to start. Wonderful opportunity to own pleasant, profitable business backed by world wide Industry. Write Rawleigh Co., Dept. I-U-PSC, Freeport, Ill.

BIG bargains for big profits. Over 100 sensational values. Men's used suits $2.00, pants 35c, topcoats $1.25, overcoats $2.00, shoes 20c. Experience unnecessary. Free wholesale catalog. Superior, 1250-PA, Jefferson, Chicago 7.

100% PROFIT on famous popular Pines Birthday, Christmas, and all-occasion Greeting Cards. Wonderful 12 to 24 Card boxed assortments sell on sight for $1.00. Write today for information and Extra Bonus Distributor's Plan. S. Pines, Box 32, Flushing, N. Y.

EXCELLENT Sideline for Printing Salesmen. Decalcomania Name Plates in small quantities. Also, make money applying Initials on Automobiles. Free Samples. "Ralco", X-164, Boston (18), Mass.

AGENTS—300% profit selling genuine gold window letters; stores and offices. Free samples. Metallic Letter Co., 437 N. Clark, Chicago.

AT last! Something new and sensational in Christmas cards. Amazing "Oilette" cards. Like costly oil paintings. Designs never before offered. Gets orders fast. Beautiful 25 for $1 Cards, name imprinted. Many other assortments. Big profits. Samples on Approval. Puro Co., 2801 Locust, Dept. 641-L, St. Louis, Mo.

AMAZING New Zipper Shoe sells on sight. Big profits for salesmen. Leads line 200 splendid styles. Territories open. Get Free Sample Outfit. Write Consolidated Shoe, Dept. S-204, Chippewa Falls, Wis.

"OUR Flag"—famous picture. Four colors. 500,000 sold. Sample print—Free. Our Flag Sales Corp., Dept. C-1065, Excelsior Springs, Mo.

CHRISTMAS Cards. Earn Big Money. Take orders galore from friends. 25 exquisite folders with name $1.25. Free samples 10 designs. America's Fastest Selling 21 Christmas Folder box. Costs 50c. Sells $1. Request samples today. Sunshine Art, Dept. N, 115 Fulton St., New York City.

CLEANS dishes without "washing." New Invention. Lightning seller. Dishes gleam like mirror. Samples sent on trial. Kristee 126, Akron, Ohio.

WE pay you $25.00 for selling fifty $1.00 boxes. Think of it! 50 beautiful assorted Christmas cards sell for only $1.00, your profit 50c. Write today for free samples. It costs nothing to try. Cheerful Card Co., Dept. 247, White Plains, New York.

BIG commissions—selling to stores celluloid Pricing Tickets, metal shelf moulding. To restaurants, menu covers, signs. C. Pricing Press, 124 White St., New York 13, N. Y.

GOLD lacquered Window Sign Letters. Large Sizes Penny Each. New Foils. Absolutely Beautiful. Free Samples. Atlas, 544 W. 79th, Chicago 20.

EASY money now to Christmas. Up to 100% profit selling friends, others, marvelous new 1946 Christmas and year 'round box assortments—30 boxes 35c up. Odd cards $2\frac{1}{2}$c up. Extra bonus. Request special feature $1.00 Christmas assortment on approval. Send today for free samples of our fast selling 50 for $1.00, 25 for $1.00 personal Christmas cards and personal stationery lines. Special offers. New England Art Publishers, North Abington, Mass.

FASCINATING income building plan. Take easy orders from friends, fellow workers, Church organizations for fast-selling Christmas, all occasion, gift wrapping, birthday, get-well, correspondence notes assortments. Sell for $1.00 each—cost you 50c up. Extra bonus. Experience unnecessary. Request foremost $1.00 Christmas box on approval. Special offers. Bluebird Studios, Dept. 17-K Fitchburg, Mass.

UP to 100% profit selling friends outstanding $1.00 Christmas card assortment. Costs you 50c per box. Also Religious, Gift Wrapping, Birthday assortments 35c up. Extra bonus. Request sample $1.00 Christmas box on approval. Free sample 50 for $1.00, 25 for $1.00 personal Christmas card and stationery portfolios. Special Offers. Elmira Greeting Card Co., M-163, Elmira, N. Y.

SELL Christmas cards. Easy money showing exquisite Christmas, Everyday, Wrapping assortments, Stationery. Over 100 quick sellers. Request $1.00 Christmas box on approval. Free samples of 50 for $1.00 Christmas cards. Special Offers. Hedenkamp, 343 Broadway, Dept. S-20, New York 13.

NEW, extra money plan. Up to 100% profit showing friends unusual Personal Christmas cards, Box assortments, Gift Wrappings, Humorous, All Occasion, Birthdays, Social Notes, Personalized Stationery. Extra bonus. Request Free 50 for $1.00, 25 for $1.00, 25 for $1.95 name imprinted Christmas Cards and personalized stationery folder. Special Offer. Thomas Terry Studios, 290 Union Avenue, Westfield, Mass.

SELL full, part time. Individualized belts, buckles, cap badges, tie holders. Thousand emblems. Every veteran prospect. Fast profits. Repeats. Write today special outfit offer. Hook-Fast, PS Box 1425 Providence, R. I.

300 MONEY Making Deals, Plans, Rare formulas, Schemes. Folio Free. Formico Co. Box 572, Dayton, Ohio.

"27" AGENTS.—Salesman Wanted! Liberal territory alloted. Demonstrate amazing "27 Second" eye glass Cleaner, Whirlwind seller. Year's supply in compact only 59c, 2 for $1.00. $40.00 per gross—110% profit. 27 Second Cleaner Co., Dept. 29, 6337 N. Talman, Chicago 45.

SELL Christmas Cards 50 for $1.00 with customer's name imprinted. Your profit 40c. Free Portfolios. Also Box assortments sell for $1.00. Your profit 50c. Elmcraft Co., 5930 S. Western, Chicago 36, Ill.

BUILD Year Round Lifetime Business, sell everyday necessities to stores, institutions, industrial plants, homes, etc. Easy repeats. Excellent profits. Great cooperation. Become territory distributor. Investigate. Lytle Supply Co., Ave. 12, Fredericksburg, Ohio.

SELL New—used clothing from home, auto, store. Men's suits $1.09. Leather Jackets 49c. Overcoats $1.00. Dresses 22c. Ladies' coats 38c. Other bargains. Catalog Free. S & N, 565A Roosevelt, Chicago.

NEW Exterminating Business. Nets you big profits first day. We help you start your own fine business with revolutionary, completely automatic Insecto-Death Vaporizer process that kills dangerous insects and even destroys their eggs. Harmless to humans, pets, foods. Write Now for exciting details. Kundra Laboratories, 2950 N. Halsted St., Dept. A, Chicago 14.

EXTRA money. Up to 100% profit selling friends new 1946 assortment of 21 magnificent Christmas cards. Sells for only $1.00. Costs you 50c up per box. Amazing quality and value thrill all. Also fast selling $1.00 Christmas gift wrapping, religious and everyday assortments. Experience unnecessary. Write today for customer-getting sample 21 Christmas box on approval. Holiday Card Co., 463 Congress St., Dept. C, Portland, Maine.

SELL Christmas cards, 50-25 for $1.00, names imprinted. Samples Free. Also box assortments. Dunbar Cards, New Brunswick 21, N. J.

$1.00 starts you in business. Sell DeLuxe ties, 100% wool interlining. Costs you only $7.00 per dozen, you make $5.00 dozen. Send $1.00 for special introductory offer two DeLuxe ties. Catalog complete line Free. Philip's Neckwear, 20 West 22nd St., Dept. P-3, New York 10.

TREMENDOUS Profits! Sell Mothproofing Solution to housewives. Employ subagents. Sell to stores. Experience unnecessary. Postal brings details. Kinford, Wayne 44, Penn.

SELL Christmas Cards, Everyday Cards, Pictures, Books, Novelties, Big profits. Bulletin Free. Elfco, 432 North Wells, Chicago 10.

EXTRA money selling sensational 21 card $1.00 Christmas assortment—your profit up to 50c per box. Request sample 21 Christmas assortment on approval and free samples 50 for $1.00, 25 for $1.00 name imprinted Christmas cards. Joyous Greeting Card Co., 373 Connecticut St., Dept. F-1, Buffalo 13, N. Y.

EASY money. Sell friends sensational 50 for $1.00 personal Christmas cards. Also extraordinary Christmas card, Everyday, Gift Wrapping boxes. Quick sales. Up to 100% profit. Experience unnecessary. Write today for Free self-selling sample portfolios 50 for $1.00, 25 for $1.00 name imprinted Christmas cards, personal stationery. Special offer. Rainbow Greeting Card Co., 36 East 12 St., Dept. 28-A, New York.

MENDENHALL really has mdse. for agents and Dealers. Free Literature, Mendenhall, Beckel Bldg., Dayton, Ohio.

BIG profits selling used clothing, etc. Operate from home, auto, or store. Sensational low prices. Catalog free. Kadetsky & Son, 702 Barber Street, Dept. 10, Chicago 7, Illinois.

LIQUID Glow makes everything "glow in the dark". Easy sales, big profits. Royal Glow, 1472 Broadway, New York.

GREETING Card moneymakers. Birthday, Everyday, Christmas. Write for folder. Greenport Art Company, (Dept. 9C), 252 12th St., Brooklyn 15, N. Y.

LOW Priced six cent Cigars. S. Kelley, 2302 Ontario St., Ft. Wayne 6, Ind.

$3 FIRE Extinguisher sells wholesale or direct. "Fire-Killer", Zone 1, Syracuse, New York.

CHRISTMAS Cards, Correspondence Notes, Stationery, Novelties. For stores, agents, clubs. 4154B Fifth Street, Philadelphia 40.

COLLEGE Students! 100% Profits selling Costume Jewelry. W. Morris, Maywood, N. J.

HARMONICAS $10.80 $18.00 $24.00 $36.00 $45.00 dz. Harmonica Wholesalers, 11 E. Centre Street, Baltimore 2, Md.

BIG Profits Taking Magazine Subscriptions. Supplies free. Enclose 20c for Postage, handling, etc. William V. Trowbridge, 35 Woodcrest Avenue, Dayton 5, Ohio.

"WONDER cleaner, New Type bubble bath Glasglo, sell fast. Tremendous profits. Supplies, circulars, furnished. Courier, 3829-H, Belmore, Cleveland Heights 21, Ohio."

SCHOOL Seniors—Sell classmates America's most beautiful, distinctive Graduation Name Cards. 40% commission. Largest selection. Lowest prices. Free cards and sample kit. Printcraft, 1425 E. Elm St., Scranton 5, Pa.

25 ways to make money with Luminous Paint. (Shines in dark). Rush 25c for profitable folio and Luminous sample. Address Lite-Saver, 97B, Saybrook, Connecticut.

PAINT plaster plaques; statuary. Sell locally. Beautiful, clear detail. Strong, hard castings. Guaranteed quality. Fascinating! Popular! Profitable! List free. Samples $3.00. Artists' brushes, paints, instruction books available. Pioneer, 294B9, Austin, Minnesota.

SALESMEN, Expansion Bracelets, make big money, cost $4.00. Sell for $8.00. Send $5.00 for Sample. All Particulars, Returnable. Guerrin & Overholt, 350 Park Ave. Portsmouth, R. I.

SCHOOL Seniors!!!! Your postal will bring our wonder, Kwick-Sell Cardalog of popular Graduation Name Cards. Biggest profits!!! Only firm giving free souvenir chest and Card Case. Don't miss out! Hurry that postal!!! Craftcards, Box 235 (M), Pittsburgh 30, Pennsylvania.

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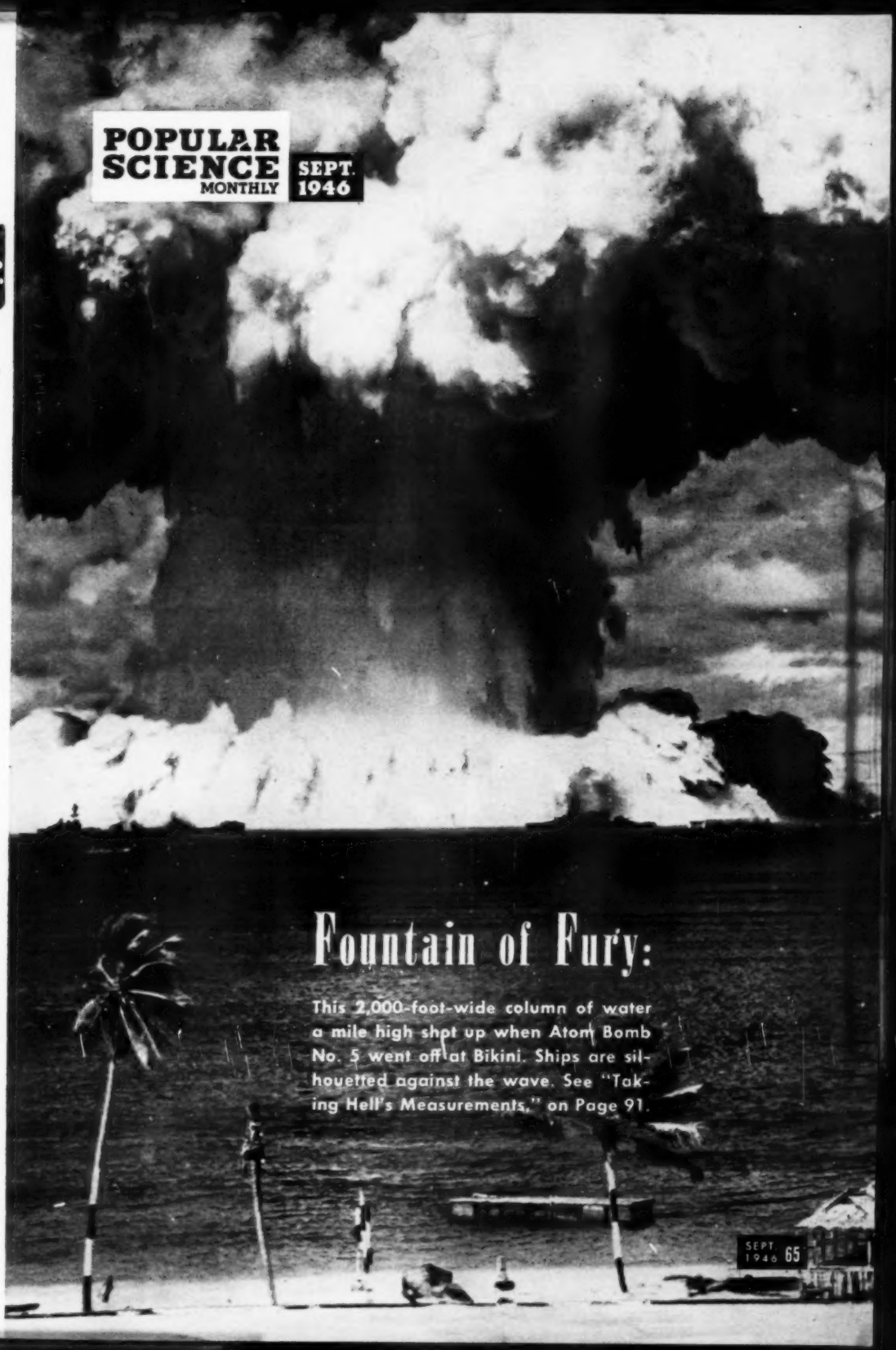
BUILD D.C. Arcwelder without rewinding armature. Plans $1.00 each 25 to 600 amperes from Automotive d.c. motors, Light plant generators, Automobile starter-generators. Welders Club, WB-3432, Chicago 54.

BUILD "Man sized" 110/220 volt A-C welder from easily found material. 10-180 amp. production type, hairline current adjustment. Highly efficient, equals factory machines. No junk. Copyrighted drawings-instructions, $2.00 (Guaranteed) Wilson Welders, Hollins 1, Alabama.

NEW small truck for small welding tanks. Rubber tires. Ball bearing. Nice for body shops. Eighteen dollars. Soldering Flux for dirty rusty jobs. Two dollars. Brazing flux for hard to clean cast iron. One fifty. Aluminum Flux. It's nice. Two fifty. General Welding Supply Co., Colvin Sta. Box 77, Syracuse, N. Y.

AT LAST!
THE HEROIC STORY OF THE MAN AMERICA ALMOST FORGOT!
The story of Johnny Montgomery who made the first controlled flight in a heavier than air machine . . . the story of Johnny and the girl whose love for him made it possible!
COLUMBIA PICTURES presents
Glenn FORD Janet BLAIR
IN
GALLANT JOURNEY
WITH
CHARLIE RUGGLES • HENRY TRAVERS • JIMMY LLOYD
Original screenplay by Byron Morgan and William A. Wellman
Produced and Directed by WILLIAM A. WELLMAN
COLUMBIA



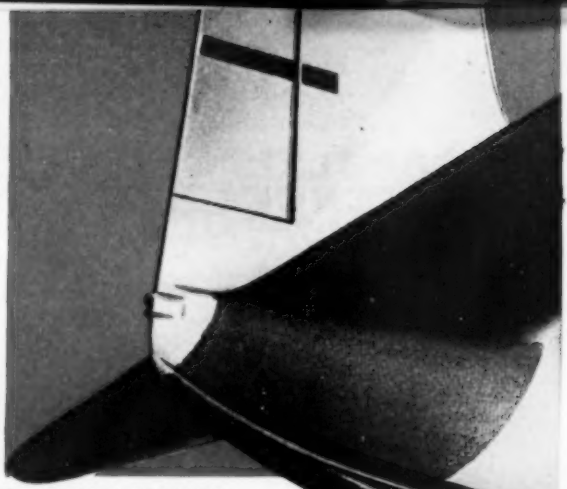
POPULAR SCIENCE MONTHLY
SEPT. 1946

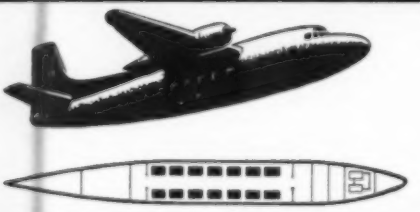
Fountain of Fury:

This 2,000-foot-wide column of water a mile high shot up when Atom Bomb No. 5 went off at Bikini. Ships are silhouetted against the wave. See "Taking Hell's Measurements," on Page 91.

air travel for everybody

By DEVON FRANCIS

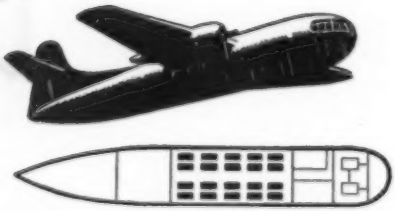




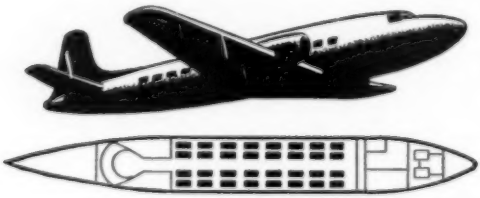
Planes with 10 to 15 seats, like the Lockheed Satellite above, will be used on feeder lines to bring even small communities into the U.S. air network.

IN A half-dozen plants converted to peacetime pursuits, riveting hammers are pounding out aircraft to bring transportation by air to thousands of American hamlets at a price almost any traveler will be able to afford.

Some of these air liners, built from design lessons learned during the war, will be able to cross the United States in less than seven hours. Some, engineered specifically for local flights on interurban schedules, will be only half that fast. All of them, for the first time in the history of U.S. air trans-



Transports seating 20 to 25, cruising at 200 m.p.h., will step up present speeds on minor trunk lines.



Faster runs on major trunk lines will be provided by 300-m.p.h. planes seating 40 to 60 passengers.

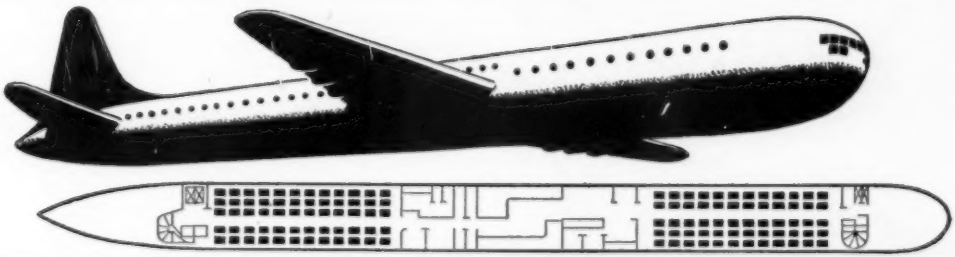
port, are being built for specific purposes.

Conveniences for the traveler that these planes will provide reflect the public's criticisms of the air carriers for the last decade. They also provide a pretty good picture of what the public wants—and is going to get—from the air lines in the next five years.

The public is fed up with traveling at 200 m.p.h. between terminals and then waiting 20 minutes or more to retrieve a traveling bag, laboriously unloaded from badly designed transports. So, presently, the air passenger will be able to carry his own bag aboard and stow it under his seat or in a rack over his head, or in a special baggage compartment at the plane's entryway.

The public is fed up with all the hocus-pocus paper work, at reservations counters, airport terminals and even aboard the airplanes themselves, that takes passengers' time and delays departures. So, on shorter runs at least, a passenger presently will be able to walk up to an airport ticket desk, buy his passage, show it at the gate and go aboard without the bother of a reservation.

The public is fed up with time wasted



When they enter commercial service, giants like the Convair Model 37, carrying up to 200 passengers at speeds in the 350-m.p.h. class, will handle intercontinental and express transcontinental traffic.

Telephone service (left) will be available to passengers on the ground. This will be one of the conveniences for through travelers, who will no longer have to leave transports at intermediate points.

at stops. So in one type of transport the time spent on the ground will be cut by providing one door for boarding passengers and another for those getting off.

The public wants air lines that go to a lot more places on the map. It wants to be able to travel by plane when the weather is stinko. It wants adequate ventilation in planes that are not too hot and too cold by spurts. It wants altitude conditioning on *all* transports, so a man's ears won't hurt as his plane descends to land.

On long flights, electric stoves will permit preparation of varied meals aloft, in contrast to the vacuum-bottle menus that are served on air liners in use at present.

That 20-minute wait while luggage is unloaded will be eliminated by luggage space in the passenger compartment (below). It will also obviate tipping, since travelers can carry their own bags aboard.

It also wants more speed for its dollar.

All these it is going to get, plus a few more. By 1951, air transports and the air-line pattern itself, both domestic and intercontinental, will confound the most extravagant predictions of the men who were nursing a few scrawny air lines to maturity in 1931.

But for all the planning that is under way, the growth and character of air-line service are bound to be somewhat hodgepodge for the next few years. The carriers themselves are guessing at exactly what's coming. They are in the midst of a tepid re-enactment of the railroads' expansion three-quarters of a

Eating from lap trays will be a thing of the past. Roomy tables (right) will be available for meals or card playing. They will supplement lounges and buffets on the larger intercontinental transports.

century ago. It is a tepid performance because the air lines are rigidly—some critics say too rigidly—controlled by the Government.

What's best—cheap transportation in economically run "day coach" planes, or higher-

Some of the individual conveniences in store for the air passenger of tomorrow are shown at left. More personal comfort is the keynote.

cost transportation on plush seats? American Airlines, biggest U. S. carrier, favors low-cost travel for everybody. Many of its competitors are increasing, instead of cutting down, the plush.

What's best—200-m.p.h. planes at a cost to the passenger of three and a half cents a mile, or planes that will fly at 350 or 400 m.p.h. with considerably higher fares? That question is in a fair way to being answered. The slower planes will go on interurban runs, the faster ones on transocean and one-stop and nonstop transcontinental runs. In-between planes will fly middle-distance runs.

What's best—planes that sacrifice cruising speed for the ability to get into tiny airports, or faster planes that need more runway? That is the hardest question to answer. Good airports are few, and cities and towns are loath to put up money for better ones even if the Government chips in.

What's best—14-passenger planes that leave every hour, or 28-passenger planes that leave every two hours? Some aircraft manufacturers, hawking their wares among the air lines, are betting on the smaller plane.

One thing is certain: Faster, more efficient planes are coming. They will go farther on a gallon of gas, and that means lower fares. One manufacturer already is talking about the possibility of New York-to-San Francisco flights in less than eight hours for as little as $86. That compares with $118.30, tax extra, at present. The Pullman fare for the same trip is $127.13 (or 4.01 cents a mile); that by rail coach, $63.12; by bus, $45.25.

The Air Transport Association, the air-line trade group, figures that average domestic fares in the next few years will drop to three and a half cents, and in its boundless and evidently warranted optimism forecasts flights made on "trolley-car frequency, with

no requirements for advance reservations."

That figure, three and a half cents, probably is stretching it a bit. Individual aircraft manufacturers and carriers say four cents would be more like it.

A Plane for Every Purpose

The A. T. A. believes that the current, frenzied purchase of new transports by the air lines to cash in on a war-born bonanza of patronage ultimately will create an orderly, stepped-down pattern of air-line equipment:

Planes with 80 to 200 seats for intercontinental flights.

Planes with 40 to 60 seats for main trunk lines.

Planes with 20 to 25 seats for smaller trunk lines, such as those of considerable length over sparsely settled areas.

Planes with 10 to 15 seats for feeder lines serving communities with populations as small as 2,500.

All-cargo planes.

The main trunk lines also will have a certain number of 80- to 125-passenger planes for one-stop or nonstop coast-to-coast schedules. Some of these, in turn, will be fitted as sleepers.

In their anxious, keep-up-with-the-Joneses buying of new transports—a windfall, by the way, to aircraft manufacturers who had billions in war orders canceled overnight—the air lines really deserve a little sympathy. They are in a dither. They are filthy rich in patronage but they want more.

Slide-Rule Answers

In casting around for answers, the only real truths the carriers can get their teeth into are those that can be proved on a slide rule. They know that the volumetric capacity of a conventional airplane varies as the cube of its linear dimension, while fuselage structure weight varies roughly only as the square. Put in plain language, that means the bigger the airplane, the more profit. As yet the theory of small planes for short runs is only a theory. People may begin using airplanes as they use buses.

If the air lines buy big planes, which can be operated more economically per seat than small planes, they stand to lose their shirts if they don't carry good-sized loads. If they get timid and buy small planes of only fair speed in anticipation of modest patronage, they not only risk the larger profits on more expensively operated equipment but may lose customers as well to competitors with bigger, faster planes. They can't hook on a glider to take care of overflows as a railroad hooks on an extra car.

Whatever they buy, the public will benefit. More than 300 companies have filed applications with the Civil Aeronautics Board, the agency which rules the industry with an iron hand, to establish feeder routes. Right now only 61 of the nation's 665 communities with populations of 10,000 to 25,000 enjoy air-line service. Almost half the nation's counties have no airports. Of the 678 points that feeder and trunk lines propose to add as stops, only 93 have satisfactory airports.

That means a lot of heat is to be put on American cities and towns to build new airports or improve old ones. The more airports, the more places the air-line customer can fly.

Transports Speed Up

In the next five years he will be flying faster, too. Yesterday's standard air-line speed of 170 m.p.h (advertised tongue-in-cheek as "three miles a minute") is being boosted right now with transports, some of them remodeled from the war, that do 200 to 275 m.p.h. Even short-haul transports like the new 14-seat Lockheed Saturn will travel 200.

The 24-passenger Boeing 417, a pint-sized companion of the same company's Stratocruiser, will fly at 196 m.p.h. The 40-passenger Martin 202 will make a bit less than 300; the 40-passenger Consolidated-Vultee 240 type, a full 300; the 52-passenger Douglas DC-6, a little more; the 80-passenger Stratocruiser, 340; the 200-passenger Consolidated-Vultee 37 model, 340, and the 46-passenger Republic Rainbow, 400.

All of these planes are on order. No deliveries to air lines will be made on any of them before the end of this year, and most of them won't be off the production lines until 1947 or 1948. The Convair 200-passenger job, commercial version of the Army's C-99, won't be flying before 1950.

The air-line customer may expect to fly higher. All the new transports except those devoted exclusively to short hauls will be pressurized for altitudes of at least four miles, and new techniques will maintain sea-level pressure to as high as three miles.

Wellwood Beall, Boeing's chief engineer, believes that long-distance flights at altitudes "considerably in excess of 30,000 feet may soon be commonplace."

The Rainbow, in fact, is designed to climb to 40,000 feet, above the weather. Even combat planes seldom went that high during the war. Designed specifically for great altitude, the Rainbow costs less to operate at a height of almost eight miles.

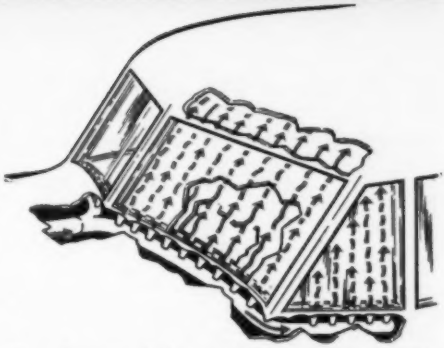
In five more years, and maybe less, the person who makes an air trip of considerable length will draw his final dividend from the war in comfortable flying. It was the war that accelerated work on the turbine as a power unit. Today the turbine, driving a conventional propeller and spewing burned gases from a jet pipe for supplemental thrust, is being installed in a version of the new Martin transport for experimental cargo work by United Air Lines. When it has proved its reliability, it will be fitted to passenger transports.

Turbine power, in contrast to that obtained from reciprocating gasoline engines, is practically vibrationless. Gone will be the aggravating, often nerve-wracking shaking that has always characterized powered flight. Because turbines produce more power per pound of weight, their adoption will mean even greater speeds; 400 m.p.h. will be no novelty. It will also mean bigger planes if the volume of passenger traffic calls for them. Consolidated-Vultee won't attempt to build a Model 37 until it can get turbines of 5,000 horsepower.

The general adoption of turbines for long-range flying, incidentally, will make operation at high altitudes mandatory. Turbines work better higher up. Altitude flying will obviate the "bumps" encountered in the turbulent air of storms, high winds and heat reflected from the earth.

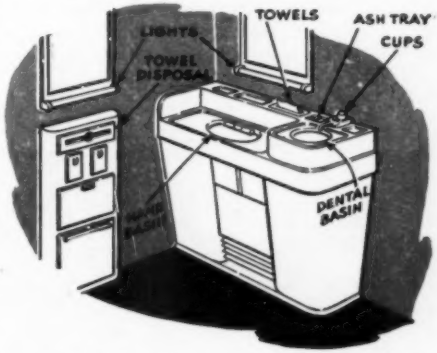
Give the aircraft manufacturers credit. Trying to keep their heads above water amid ruthless competition, they have done most of the work in the year since the war ended to make flying more enticing to the air-line customer. The carriers themselves, spoiled by six years of more business than they could handle, too often have been characterized by the reservation clerk who is snippy over the telephone.

The plane makers weren't blessed with that problem They had to go out and get business. To sell planes they had to build better ones, with more appeal. So they are shooting the works.



The pilot's needs have not been forgotten. This windshield has two glass panels, with warm air flowing between them to prevent fogging on the inside and icing outside. Each panel is crash-proof, a safeguard against collisions with birds.

Automatic radiant heating for cabins will maintain perfect temperature control, eliminating the now-it's-too-hot, now-it's-too-cold complaints. Other comforts will include complete air conditioning and pressurized cabins in high-altitude craft.



Improved facilities, such as the Pullman-type fixtures illustrated above, will be among the features of more spacious powder rooms for women and lavatories for men on main-line planes.

Prewar racers, like the one made by Steve Wittman of Oshkosh, Wis., are today far outdistanced by stripped-down, factory-built warplanes.

"POT-of-GOLD" FLYING

THE "money fliers" of American aviation are back at the National Air Races in Cleveland this year, and the men and their planes mark the passing of an era.

The homemade jaloppy, an airplane characterized by inexpertly scissored wings and souped-up engine, with which the pilots of yesteryear sought quick riches, will have to compete at the first of the postwar races against fighter planes bought by ambitious pilots from government surplus.

These expensive, factory-designed planes have been cleaned up to capture prize money in the famous cross-country Bendix Trophy Race, the closed-course Thompson Trophy Race, and the in-between races worth a little less money.

The time was when a good mechanic, working in his own backyard, could construct a racing plane that stood a fair chance of winning a substantial chunk of the more than $100,000 in prizes offered for speed.

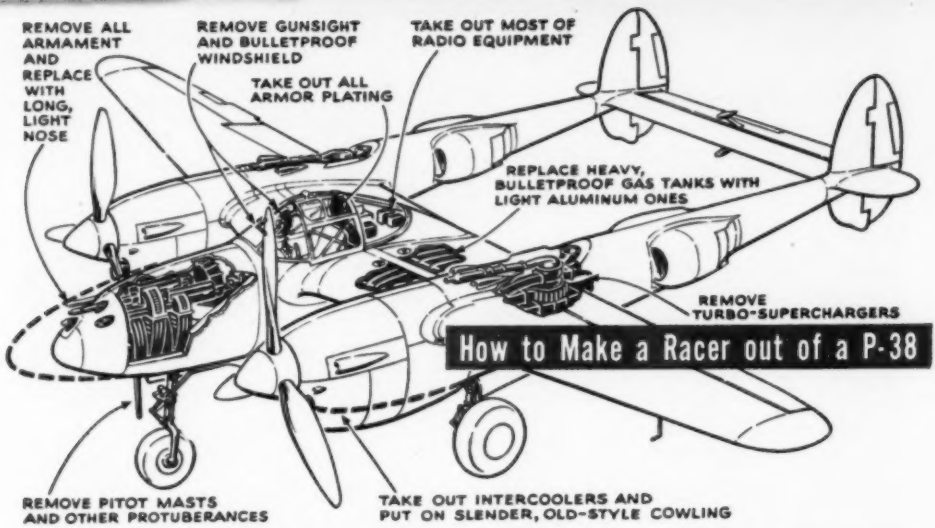
He resorted to all sorts of tricks to get speed out of his clipped-wing mount. He filed down the cylinder cooling fins to cut the weight. He razored his wings until they would hardly sustain him in the air. He stepped up his carburetor-feed system to meter more fuel to his engine.

That was up to 1939, when the races were last held. Then came the war. Airplane designers wrested from physical laws a whole new world of knowledge about speed in the air.

Four or five pilots are flying souped-up Lockheed Lightnings this year. Some have entered Bell Airacobras and North American Mustangs. Tony LeVier, veteran racing pilot and Lockheed test pilot, has lightened his

THESE PLANES HAVE WON

Douglas Davis 1929 — Jimmy Doolittle 1932 — Harold Neumann 1935



Lightning for the Thompson race as shown in the drawing on this page. He sheared 2,300 pounds from the plane's 17,000-pound take-off weight.

War-born speeds have done more than make it difficult for the amateur designer and builder to place in the money this year. They have necessitated separating the airplanes with reciprocating engines and propellers from those powered by jets. The jets, too fast for the propeller planes, will compete in a class of their own.

Air racing, companion piece to automobile racing, is dangerous. Things can go wrong. Oil lines break. Oil pumps fail because of too much pressure. Fuel lines break. On in-line engines, coolant tubing can fracture. Excessive manifold pressure, thrust into the engine by a too-anxious hand on the throttle quadrant, can blow cylinder heads. Men sometimes have blacked out and lost control on pylon turns. They have stalled on turns and spun into the ground.

Air racing is also heartbreaking. In 1937 Roscoe Turner was out in front in the Thompson until he cut a pylon on the nineteenth lap. It cost him the race. In 1935 he was seven miles ahead at the start of the final lap when engine trouble forced him to drop out.

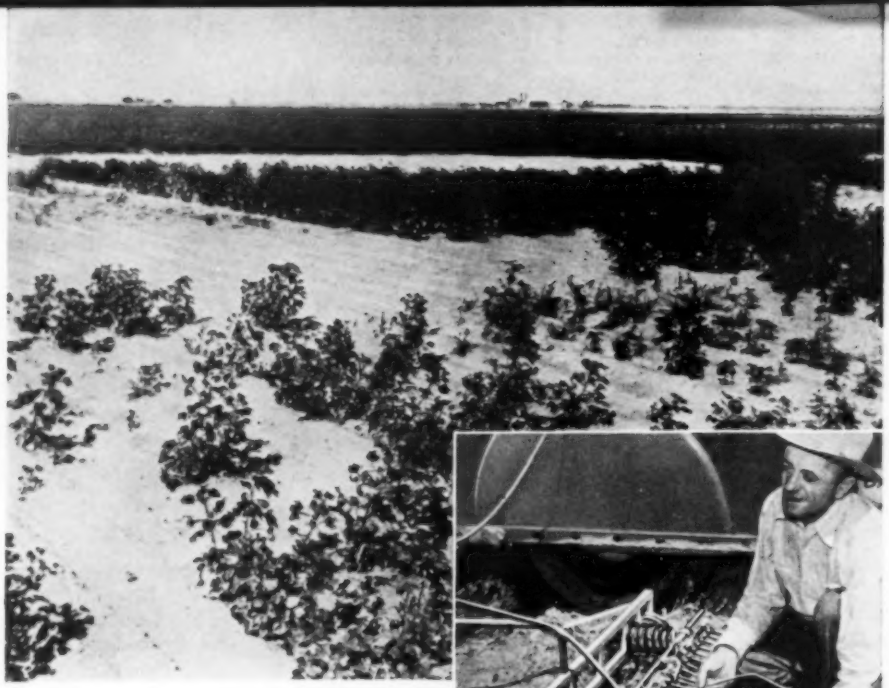
"Everybody's saying 'tough luck,'" boomed Turner into the microphone of the loudspeaker system in front of the spectators' stands after he had brought his ailing plane to a dead-stick landing. "I don't think so. When you can walk away from that kind of an airplane, I think that's good luck!"

The races ought to be safer this year. Planes are better constructed. The pilots have had more experience in high-speed flying. They are required to wear anti-blackout suits, crash helmets and parachutes.

But the pursuit of the pot of gold will still be dangerous. With big money within his grasp, a pilot cannot be expected to fight off the temptation to use water injection for extra power and force his engine beyond its designed stress limit.

WORLD'S RICHEST AIR-RACING PRIZE

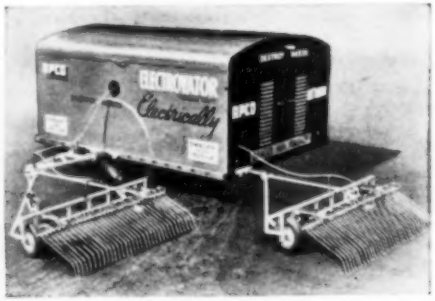
Michel Detroyat 1936 — Rudy Kling 1937 — Roscoe Turner 1938, '39



Shocking Weeds to Death

A MOBILE electrocution chamber that shocks weeds to their root-tips is the newest weapon in the battle against weed infestations that cause U. S. losses of more than $5,000,000,000 a year in crops and land values. The machine, called an Electrovator, is the invention of Gilbert M. Baker, of Mendota, Calif.

It is a trailer containing a gasoline-driven 12.5 kilovolt-ampere generator and a special transformer. Two rakes with copper electrodes for teeth transmit the high-voltage, low-amperage current to weeds as the machine is drawn at one mile an hour by a jeep or tractor. The weeds burn, from tops to root-tips, leaving the land ready for new crops. The treatment can be repeated for successive growths at a cost of $10 per acre per treatment. The Avco Corporation, of Los Angeles, distributes the machines.



The bare patches of ground in a cotton field (top) show where the weed killer has been at work. In inset, Mr. Baker displays the "stingers" of his machine—flexible rods, connected to the transformer, that ride along the surface of the ground. A control panel in the towing vehicle varies the charge transmitted by the rods to suit different kinds of weeds and soil. Above is the Electrovator itself, showing the overlapping arrangement of the two rakes and their connections for towing and power.

Paper Gets Tough for New Jobs

With wet-strength plastic bonding, it takes to water and rough wear.

By LLOYD STOUFFER

IN JULY 1943, members of an Armored Force troop at Camp Hood, Texas, were handed a map made of a new kind of paper, with orders to find out what kind of punishment it would take.

They returned from the field a week later to report that the map had been: (1) soaked in water 20 times and wrung out violently; (2) repeatedly folded and beaten with rifle butts; (3) smeared with grease and paint; (4) drenched in gasoline; (5) trampled in mud; (6) boiled in soapy water and scrubbed with a GI brush; (7) tacked to a mess-hall floor where a whole regiment walked over it, and (8) run over by a tank.

All this, they reported, "did not noticeably affect" the map.

That was the Army's introduction to wet-strength paper. It looks like any other paper, but its fibers are bound together, invisibly, with a tiny amount of plastic.

Wet-strength treatment is simple and inexpensive. Now that military needs have eased, it is being extended to hundreds of everyday paper articles to give them amazing strength and long life, wet or dry.

Have you encountered paper towels that no longer fall apart in your wet hands, no longer leave annoying lint on your face? That's wet strength. Have you toted moist vegetables in a paper bag without having the bottom fall out, meat in a paper wrapping that doesn't disintegrate and drip on your clothes? Have you removed wrappers from ice cream and frozen foods without having slivers of paper stick? That, too, is wet strength.

Tea drinkers already have noted the surprising strength of new tissue-paper tea bags that remain intact when stirred in boiling water. Soon we will have shelf and wall papers that are really washable, cigarette paper that won't tear off on the lips. We will have long-life paper dish rags and dish towels, sheets, blankets, diapers, and raincoats. We are promised such things as paper furniture and paper baby carriages. We may even have paper houses.

After that eye-opening demonstration in Texas, wet-strength paper quickly became standard for all Army and Navy maps. The Army used 400,000,000 wet-strength maps during the war—125,000,000 in the inva-

sion of Normandy alone. They were invaluable in the South Pacific jungles, where it was found that ordinary paper would mildew and go to pieces in a few hours.

Wet strength is obtained with either of two plastic resins commonly found in molded articles such as flashlight cases and screw-on bottle tops.

One is urea formaldehyde, a compound of which was used as long as 10 years ago by the Brown Co., Scott Paper Co., Dennison Manufacturing Co., and others – to give added strength to paper towels and diapers. But these treatments were comparatively expensive, required special machinery for an added production step, and were not available for general use.

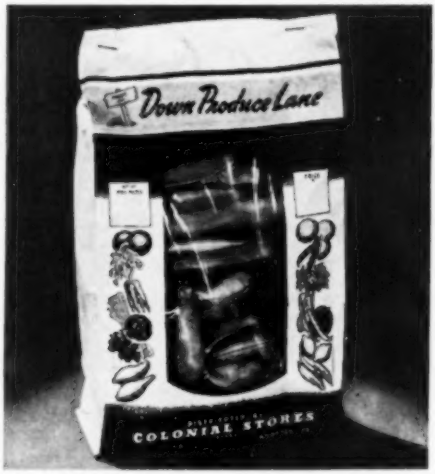
The plastic that made the unbelievably tough maps, and for the first time opened up wet strength to low-cost use, was melamine formaldehyde, developed by the American Cyanamid Co. The melamine compound was the first that could be added directly to the pulp, requiring no extra processing or equipment. Later the Resinous Products & Chemical Co. developed a form of urea formaldehyde resin that could be similarly handled. Both are widely used now.

The S. D. Warren Company perfected the wet-strength map paper. In their mills I saw how it is made. The tiny colloidal particles of resin carry a positive electrical charge; cellulose fibers (pulp) are negatively charged; when a barrel of the liquefied melamine or urea compound is dumped into the swirling pulp in a big mixer, there is a swift and even dispersion and adhesion. The pulp then continues through the usual series of heated rollers, which not only dry the mixture into finished paper but fix the resin particles in an irreversibly insoluble state. These particles bond the fibers to each other regardless of subsequent wettings.

A wet-strength bag solved a wartime home-front crisis by making possible the movement of the potato crop after supplies of burlap, traditionally used for bagging, were cut off. Farmers were skeptical, but they soon found that they could handle these paper bags, loaded with 50 pounds of wet potatoes, with as much abandon as they had ever handled burlap sacks. Now that burlap is available again, farmers are continuing to use paper. It is cleaner.

Wet strength alone, of course, does not make paper waterproof. Waterproof bags keep their contents dry because they are made up of several different plies of paper and have layers of waterproofing asphalt between the inner plies. But the outer sheet of paper must have sufficient strength when wet to resist a break or tear, for that would expose the asphalt, cause it to crack, and destroy the whole structure. Wet-strength paper may be made water-repellent by additional treatment with resin or wax.

The striking improvement of wet strength need not cost a penny more. Because of the added strength, the basic weight of toweling paper, for instance, may be reduced from 10 to 25 percent and still result in a more efficient towel. This saving alone is enough to pay for the resin, a pound of which, costing 38 cents, will treat about 20,000 9-by-12-inch towels. And although the wet-strength towel is no more absorbent, its ability to

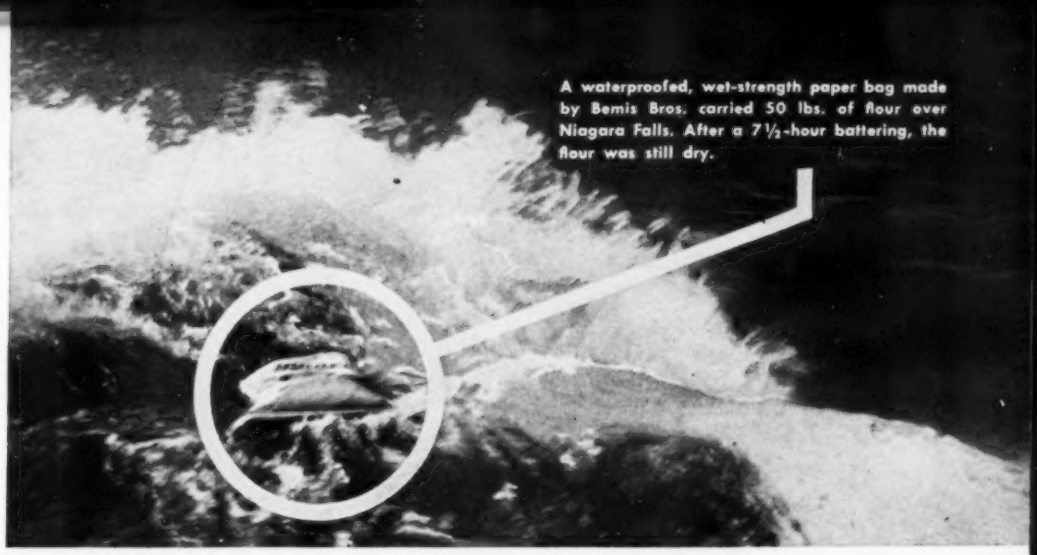


Packing fresh vegetables in this "window bag" made of wet-strength paper puts them neatly in the self-service category (Union Bag and Paper Corp. photo).

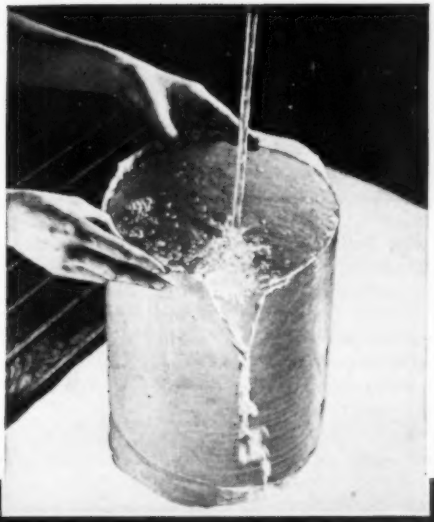
stand up under punishment until fully saturated makes it do the job for which two or three ordinary towels are customarily used.

This means important savings for large users. The Scott Paper Co., which sells its urea-strengthened folded towel at no increase in price, checked up on the washrooms of a large New York department store and found that consumption per person had dropped 14.3 percent. The store's purchases of towels were reduced by 726 cases a year.

Even in the dry state, wet-strength treated paper has certain advantages. It has greater



A waterproofed, wet-strength paper bag made by Bemis Bros. carried 50 lbs. of flour over Niagara Falls. After a 7½-hour battering, the flour was still dry.



tensile strength and greater resistance to weakening under repeated folding. It has much greater resistance to scuffing and abrasion. And because there is no linting, wet or dry, the Army and Navy during the war used thousands of tons of a soft, melamine-treated polishing tissue to clean searchlight lenses and rifle bolts.

Wet strength for the ordinary brown grocery bag—a low-cost item produced in tremendous quantities—is being introduced gradually. The householder will find these bags invaluable as liners for the kitchen garbage receptacle. Getting a package of wet garbage safely from kitchen to incinerator will no longer be a hazard.

The shopping bag at left, doubling as a water tank, illustrates the effectiveness of the plastic treatment and waterproofing, which last indefinitely.

Chipped or cubed ice is packaged and delivered directly to customers in the new paper bags. Tightly tied with wire, each bag holds 50 lbs. of ice.

Treated tissues that leave no lint, wet or dry, now are available in limited quantities to polish car windshields. They cleaned lenses during the war. (Gulf Oil Corp. photo)

But with paper still in short supply, present applications have only scratched the surface of wet-strength possibilities. For years, inventors have dreamed of a disposable paper rain cape to sell for a quarter in the corner drugstore or at football games. With wet-strength treatment, combined with water-repellency, this may be possible. Commandos, traveling light, carried such paper rain capes on their forays into France.

A Long Island manufacturer has developed for future production, when materials are available, a versatile and inexpensive beach and picnic blanket. It will be water-resistant, flameproof and sun-reflecting. Tests show that it will withstand 12 hours' immersion in water. It will also be promoted as a baby's play pad, auto-seat cover, camper's blanket and mattress cover.

Except for diapers—one of the earliest and most obvious wet-strength applications—we probably won't see paper clothing soon. For wet-strength paper when dry is like any other paper—comparatively stiff, æsthetically unappealing. But chemists are working hard to give clothlike drape to paper, and with some such lubricating ingredient as glycerine this may some day be accomplished.

With wet strength, our money will go farther—literally. The fine rag paper used for our paper currency is one of the strongest papers known, but recent experiments by the National Bureau of Standards indicate that resin treatment will give it greater folding endurance and longer life.

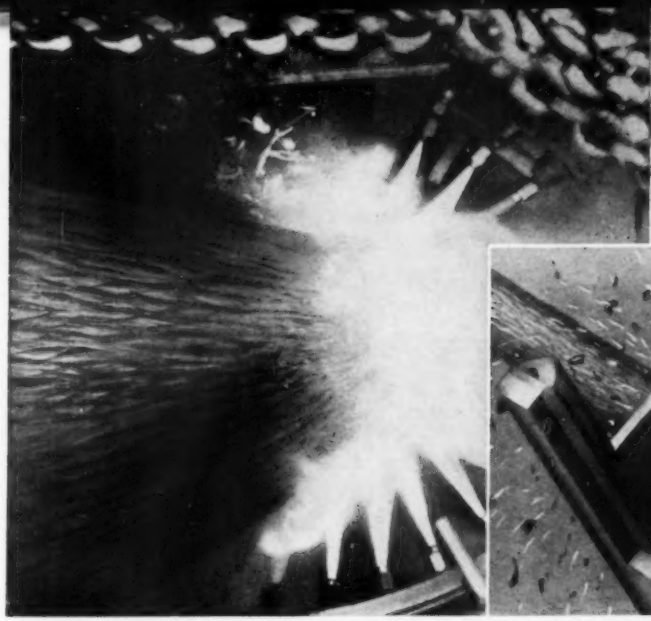
We used wet-strength paper effectively in our final offensive against the Japs. Propaganda leaflets dropped from the air on Okinawa were treated to prevent deterioration in the damp climate. Always clear and readable, and capable of being passed from hand to hand even if soaked in rain for days before being found, they brought wholesale surrenders.

For building papers, which must be expected to stand up for a lifetime regardless of the conditions they encounter, wet strength is rapidly becoming a must. Some of the treated, water-repellent papers now on the market are so strong that they are being used to cover temporary silos and as tarpaulins for cement work.

But perhaps the most striking of all demonstrations of future possibilities is a house built entirely of paper, which stands on the grounds of the Institute of Paper Chemistry in Appleton, Wis. The materials for the house itself, capable of sheltering four persons comfortably, cost $50. The inch-thick wall panels of corrugated board—not unlike the material in an ordinary shipping carton—are so strong that no framework is required.

Twenty-one panels, each about four feet by eight, form the walls, roof and floor of the 8-by-16-foot, one-room house. It has successfully withstood two years of exposure to the rigorous Wisconsin climate.

The Appleton house stands as a symbol of a wholly new concept of paper, one that forces us to discard all previous notions as to its limitations. One of the cheapest of man-made materials has incalculably extended its fields of use.



Water Skins Trees. Jets of water, under a pressure of 1,400 lbs. per sq. in. and with a velocity of 400 feet per second, have been put to work stripping bark from pulp logs. The Hydro-Barker, shown in action above, at left, blasts the bark off logs of any length and up to 60 inches in diameter. It handles half a million board feet a day, three times as much as ordinary methods accomplish, and eliminates wood loss. The inset drawing illustrates details of the equipment, developed by the Worthington Pump and Machinery Corporation and the Soundview Pulp Company at Everett, Wash.

Silent for All His Size. Tested with a General Electric vibration meter, an elephant, at right, proved to have the lightest step of all the animals in a circus. His score was three mils per second vibration, against 12 mils per second for a lion.

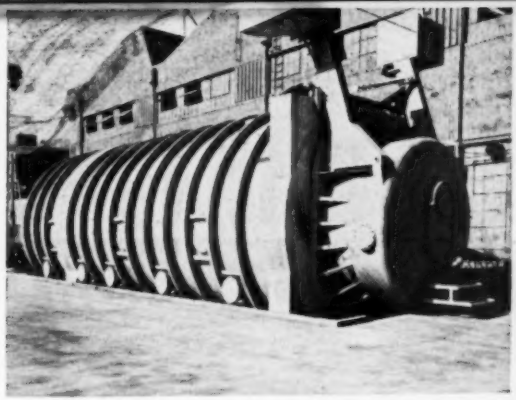
Transparent Fly Box. A lightweight plastic case devised for fly fishermen by the Bartelt Engineering Service, of Rockford, Ill., keeps individual flies separated on a revolving frame, permitting easy selection.

The 21-ton, 12-foot door of the "proving room" acts as an auxiliary altitude chamber or as an airlock for physiological tests.

75-TON TEST TUBE

Observation window in the control room looks like a large porthole. Its lens provides a 180-degree view of the interior while operator mans controls to produce enervating heat or paralyzing cold.

From an outside station at ground level, an engineer talks with the control room to report test results as seen through an observation window (rear) located halfway down the length of the cylinder.



The 75-ton, cork-lined steel chamber is 55 feet long and 17 feet in diameter, large enough to hold a fighter plane fuselage or large sections of bombers or transports for tests of entire systems.

After conducting tests at 100 degrees below zero, engineers step from the combination door and air-lock of the altitude chamber into California sunshine.

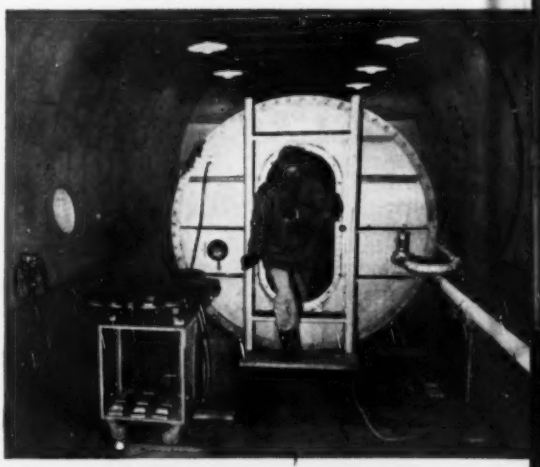
WHEN North American Aviation engineers want to test de-icing equipment under arctic conditions or hydraulic equipment in tropical heat and hurricanes, they don't have to fly thousands of miles and wait for weather. Right in their own back yard in Los Angeles is the world's biggest altitude chamber—a 75-ton test tube that can make the most severe operating conditions to order.

In 10 minutes engineers can plunge the inside of the mammoth chamber to 60 degrees below zero. Then by throwing a few controls they can rocket the temperature in 15 minutes to 200 degrees above zero. Observers can watch the performance through porthole-type windows.

North American's new research room, world's biggest, makes pressure, temperature, and humidity to order.

Air densities from sea level to 60,000 feet are reproduced to study their effect on pilots and machines. Rates of climb are simulated up to 7,500 feet per minute, and the effects of dives at speeds up to 20,000 feet a minute are duplicated. At an artificial altitude of 60,000 feet, pressure on the outside of the chamber is more than 2,000,000 pounds and in excess of a quarter million pounds on the door.

Besides creating any desired flying temperature within the giant steel chamber, engineers also can vary humidity through a range from desert dryness to fog, rain, ice, snow and sleet, achieve almost a complete vacuum, and whirlwind high-speed recirculation of air to simulate icing conditions of a flying plane.



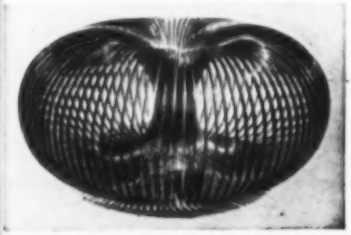
Carrying a "walk around" oxygen bottle, this test engineer emerges from a section of a giant plane within the refrigerated altitude chamber during a high-altitude test. Temperature is −100 degrees F.

"SLINKY" SPRINGS to FAME

Given an initial shove, "Slinky" eerily and deliberately flip-flops end over end down a flight of steps. It is simply a spring, but it does stunts that made R. P. James, Philadelphia engineer, think of converting it into a toy.

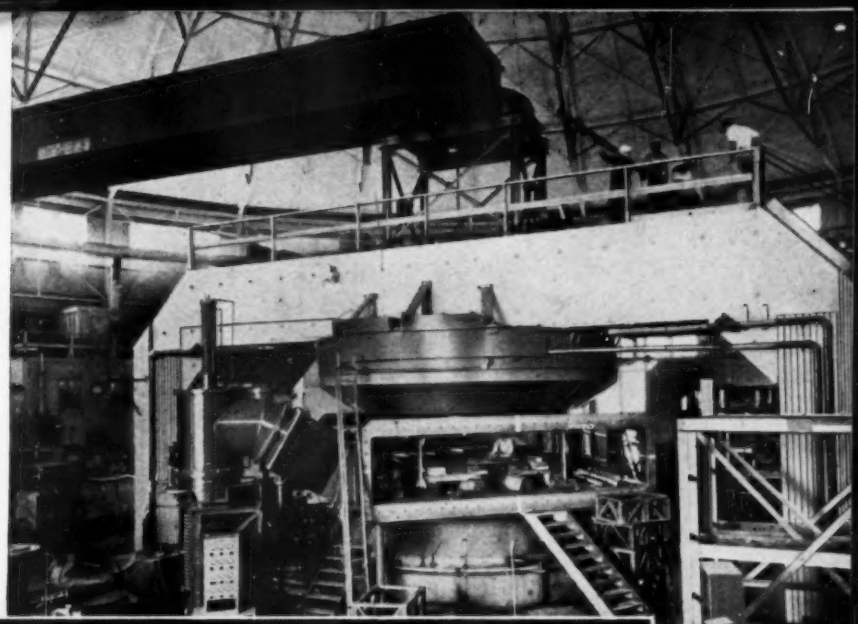
"Slinky" goes places when, with a flick of the wrist, it leaps out into space like a striking serpent. Much of its action depends on the ingenuity of its handler.

Produced in one small plant in Philadelphia, 100,000 of the springs sold so rapidly that the promoter had to subcontract to other plants in a number of cities.



The flat-coiled strip of Swedish blue steel assumes shapes in almost unending patterns. Mr. James got his toy idea when he saw the spring roll off a workbench and do funny antics on the floor.

Inert, "Slinky" (below) is a handful of spring before wriggling into its giddy gyrations for child or grownup.



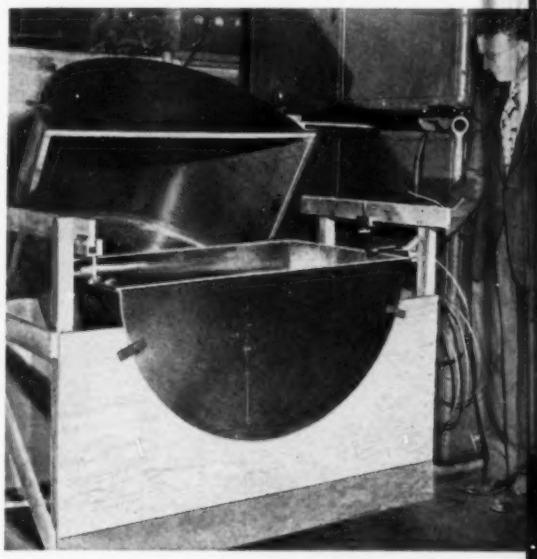
Bigger Weapons Aimed at Atoms

Between pole faces of the Berkeley cyclotron's 184-inch electromagnet (object in center that looks like the top of a funnel) is the accelerating chamber that, when enclosed, will become an almost complete vacuum. At top, 30-ton crane handles heavy parts.

THE discovery of new nuclear particles that will give a better picture of the atom and how it works is predicted by some of America's leading scientists as they make ready to duplicate a feat of nature's most powerful atom smasher, the cosmic ray.

At the Berkeley Radiation Laboratory, University of California, this fall and early next year, three strange-looking and complex weapons will be developing energies upward of 280,000,000 electron volts and firing proton bullets into atomic nuclei to produce mesotrons and contribute to the task of exploring subatomic space. Cosmic rays hurl protons into the earth's atmosphere to do the same job, but have millions of electron volts to spare.

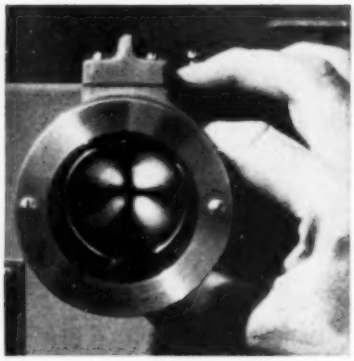
Most radical unit of this atomic battery is Prof. Luis W. Alvarez's "linear accelerator," a copper cannon that will shoot a stream of atomic bullets in a straight line instead of a spiral orbit and use radar sets to pump millions of watts of power into its tube. With it will be Prof. Ernest O. Lawrence's 184-inch cyclotron, reconverted from its wartime uses, and a new-type atom smasher, the 300,000,000 electron-volt synchrotron, scheduled for completion early next year.



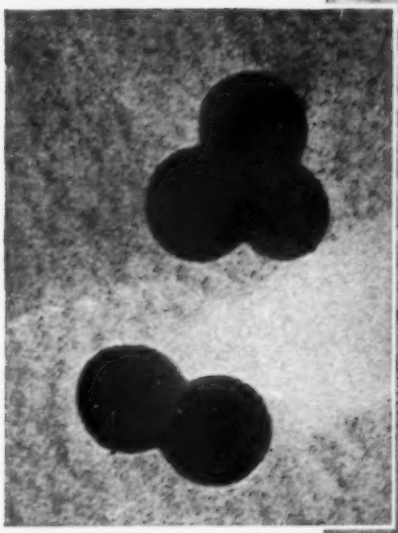
Prof. Alvarez (above) exhibits a small part of a 40-foot experimental model of his linear accelerator. Later, a 280-foot pilot model containing seven 40-foot sections will be built to speed protons to energies of 280,000,000 electron volts.

HIGH-SPEED WATER BOMB. Full-scale model of new rocket-type hydrobomb is tested in 500-ft. towing channel at Caltech laboratory, Pasadena, Calif. Launched from planes going 360 m.p.h., the 10-ft., 3,200-lb. bomb speeds through water at 70 m.p.h. Solid fuel called Galcit 65 gives engine 2,200-lb. thrust for 30 seconds to smash the bomb's 1,250-lb. war head against a hull.

MARCH OF SCIENCE



MAKING SPECTACLE LENSES TOUGH. Eyeglass lenses are 16 times stronger after a two-to-four-minute treatment in a lens-hardening unit produced by Bausch & Lomb Optical Co. Lens is first heated to more than its strain temperature but below its softening point. Photo at left shows it being placed on a lens holder before being raised automatically into electric furnace. The weight-time scale (upper left) determines the exact amount of heat needed for the weight, surface area, and type of glass of any particular lens. After heating, lens is immediately cooled by compressed air. For the final check-up, it is held in the polariscope (upper right) where strain shows up as a dark red cross.



200,000 TIMES LIFE SIZE. An electron microscope developed at the RCA laboratories, Princeton, N.J., is capable of magnifying objects 200,000 times. It distinguishes specks only 50-billionths of an inch apart. In the micrograph above, three-millionths-inch particles in polystyrene latex (a plastic) look like billiard balls.

OUTBOARD JET. A three-hp. jet engine for rowboats was recently tested on the Thames River, England, by its inventor, R. M. Parkinson. Named Aquajet Minor, the 55-pound engine runs 3½ hours on a gallon of gas, propelling the craft from three to eight miles per hour. It costs about $170.

BALL-BEARING KNIFE. Whirling on a wheel at 1,000 m.p.h., this new cutter slices human and animal tissues as thin as a quarter-millionth of an inch, or 500 times thinner than a human hair, for medical research in cancer and other diseases.

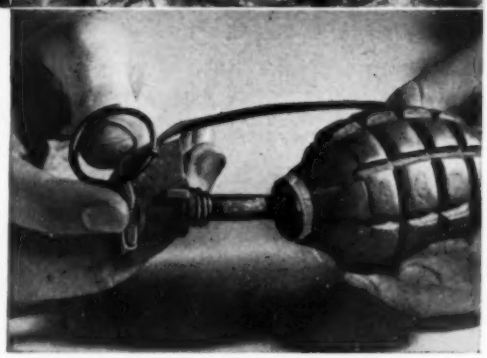
"ROCKET" ANTENNA. Resembling a rocket ready for launching, this antenna on a New York building handles FM and facsimile broadcasting for WGHF on a frequency of 99.7 megacycles. It is made by Finch Telecommunications, Inc., Passaic, N. J.

The two boys at left are engrossed in working on a 40-mm. antiaircraft shell. Their efforts might end in an explosion if the shell were not deactivated.

PSM photos by W. W. MORRIS

Bazooka shells are better left to soldiers like the man below, who knows how to use them. If you must have one as a souvenir, let an ordnance expert make it safe for you.

Enemy Weapons are Enemies Still



Even with its primary explosive charge taken out, the hand grenade shown at right remains a hazard. The fuse alone, if it is set off, can maim or kill.

By DAVID P. McNAMARA

ON A peaceful street in Brooklyn, nearly a year after the war had ended, eight American boys were badly wounded when a German 20-mm. shell exploded.

The shooting is not over yet for many of the German pistols, Italian bullets and Jap grenades that souvenir-hunting GIs brought home. Those Brooklyn boys "got theirs" from a shell that they had found in a junkyard, pried apart with a nail, and ignited with a match. Throughout the United States, enemy weapons are being found in attics, cellars, subways, streets and vacant lots. They are taking a formidable toll of fingers, eyes, hands, legs—even lives.

New York City's Police Department has begun a drive to round up such war mementos. Veterans and their relatives and friends are being urged to turn souvenirs in and let the Department's bomb experts take the fight out of them. Even these men, skilled at deactivating live ammunition, will not attempt to make anything in the artillery-shell class safe. Such a cautious attitude was scorned by some youngsters who built a bonfire under a 75-mm. shell. It killed two of them, gravely wounded four.

Booby traps, though rare, have been found and have caused damage, but the most common offenders are pistols of all types and nationalities—for even Allied weapons act like enemies when the handler doesn't know their peculiarities.

Many guns have inherent structural weaknesses that do not become apparent until they have been fired a number of

German pistols, like the three included in this display, can be even more dangerous than others. Slave workers under the Nazis often deliberately inserted weak parts, which are not particular about victims.

times. The Walther P-38, a popular souvenir, is a good example. This German automatic is dangerously unreliable because the mechanism permits the hammer to hit the firing pin even when the safety is on. When this happens repeatedly the pin weakens and may break and fire the pistol accidentally.

Many of the German Luger pistols are unsafe because they were made with odd parts, and some are worn out from long use. If the laws of your particular region allow you to keep one of these weapons, you should have it checked by an ordnance expert.

Ammunition for all foreign weapons is dangerous for anyone who does not know what the code markings on the shell casings mean. They indicate different kinds of shells. Thirty kinds fit the 8-mm. Mauser, which was the standard German army rifle.

Test shells are especially hazardous. Used to test the strength of new guns, they contain an abnormal amount of powder. Guns loaded with test shells are normally placed in a steel box and fired by remote control. If test shells are hand-fired in a rifle or pistol a few times, the weapon is likely to explode in the user's face.

Japanese ammunition is completely unreliable, and the Italians had all sorts of unpredictable ammunition. Some of their shells—no one knows why—were filled with sand. Other projectiles consist of three or four pieces of lead, which separate in flight like shrapnel.

Children and civilians are not the only victims of war souvenirs. In several instances, soldiers who went through the fighting without getting hurt have been seriously injured at home by shells or "duds" that they thought were safe. One ex-GI, trying to make a cigarette lighter out of a .50 caliber shell casing, mutilated his hand when he exploded the primer in the base of the shell by driving a nail into it.

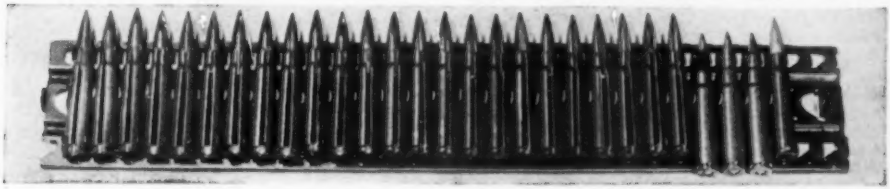
Take these tips from the N. Y. police:

Never try to fire a weapon with which you are not familiar.

Never attempt to use foreign-made ammunition, even in a weapon you know well.

Never try to deactivate ammunition or explosives; let experts make them safe.

Some of the 30 kinds of cartridges—including soft-nosed, armor-piercing, explosive and incendiary slugs—for the German 8-mm. Mauser army rifle. Used by hunters ignorant of their markings, armor-piercing bullets can rip clear through a target to strike far beyond, and incendiaries can start forest fires.



WHAT'S NEW in AVIATION

Castered landing gear, which aligns itself with an airplane's direction of motion, is being tested at the Fairchild plant at Hagerstown, Md. It allows a pilot to make crosswind landings by heading his plane into the wind, like the trainer shown above, and then sidling down the runway. At right, above, is a detailed view of the swivel gear attachment.

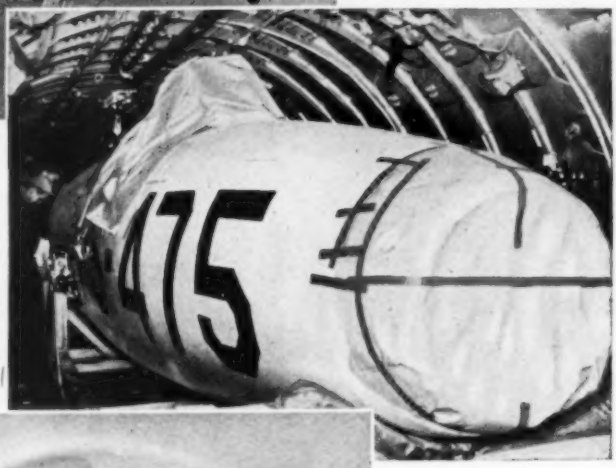
Although it weighs only five pounds, the Electrol Powerpak (below) creates pressures up to 1,500 lbs. per sq. in. to raise and lower the flaps and wheels of Republic's Seabee amphibian. A hand pump operated by the pilot produces the pressure, but openings are provided for the installation of a power-driven pump when increased weight is no objection.

Created by AAF engineers, the "Covered Wagon" life raft (above) can carry 20 passengers in comparative comfort. An inflated seat all around the interior keeps occupants off the uninsulated floor, and the inflated superstructure shields them from a hot sun and strengthens the craft against possible buffeting by high waves. If either side of the raft collapses, a bulkhead inside the rubber hull will maintain buoyancy in the other half. The stern is designed to permit mounting an outboard motor.

Snuggling in its graving dock, the Hughes Hercules (PSM, Aug. '46, p. 94) is nearing final stages of assembly. The air view above shows the wings being moved into position for attachment to the fuselage. Each wing float of the world's largest flying boat requires an auxiliary dock. Towering above the main dock, the tail (inset) awaits installation of rudder and elevators. These pictures of the plane being assembled were made before channels to the harbor had been dug.

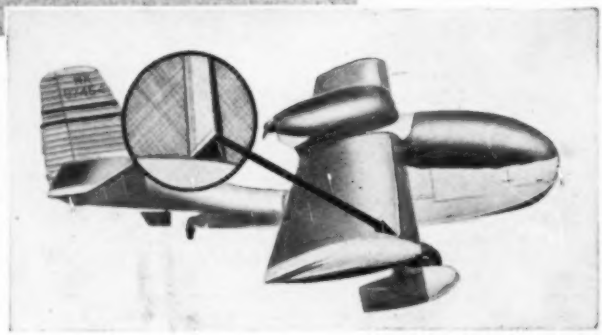
Speeds up to 675 m.p.h. are expected from Britain's De Haviland Swallow (right), which has a Goblin jet-power plant developing a thrust of about 4,000 lbs. Its fuselage is that of a modified Vampire, with the twin tail booms removed and a new fin and rudder installed above the tail pipe of the jet. It is the first jet-propelled aircraft with fully swept-back wings ever actually flown. Tiny blisters on the wing tips contain parachutes.

Known for obvious reasons as the Flying Flounder, the Navy XF5U-1, at left, has a speed range of 40 to 425 m.p.h. Its outsize propellers are driven by two 2,000-hp. engines that are inside the center section. Low-speed characteristics will simplify landing on carriers.



Packed inside the fuselage of a Boeing C-97 (right), a dismantled XP-84 jet fighter was recently flown from Farmingdale, N.Y., to Muroc Air Base, Calif., for its test flights. The transport's own loading winches hoisted the smaller plane aboard for the trip.

A specially equipped Bell helicopter (left) speeds crop dusting, one of many jobs for which the rotor-winged airplanes are particularly well suited. In this case, downwash from the whirling blades helps spread the spray more effectively than an ordinary airplane could.



To keep high winds from blowing a tied-down airplane from its moorings, the special wing cover at the right, developed by Bogardus Bros., has a firm ridge (inset) sewed in its top surface. This ridge breaks up the flow of air over the wing, just as spoilers do in slowing down a glider, destroying the wind's lifting effect.

Taking HELL'S MEASUREMENTS

At the instant of bursting, an atomic bomb is a fireball brighter than the sun. From it rises the towering smoke column and radioactive gas.

A new science, phenomenology, was tested in Blandy's Inferno.

By VOLTA TORREY

WHILE bets still were being made on how many ships the atomic bombs would sink in the Marshalls this summer, Vice-Admiral John H. Hoover said bluntly: "We won't give up surface ships." If few ships were sunk, the Navy's friends explained in the bar at Bikini, the colossal experiment being staged by Joint Task Force No. 1 would prove that sea power is not obsolete. If many ships were sunk, the same men continued, the United States would have to prepare for an atomic attack "the same way that the submarine menace was first met, by building more and more ships."

The name chosen for the operation, "Crossroads," led some people to expect a showdown between atoms and warships. Nothing of the sort occurred. The ability of certain parts of certain types of ships to withstand certain forces was tested, to enable naval engineers to design stronger ships. But the atomic bomb was not employed at Bikini the way that an enemy would be most likely to use it.

A new science, rather than a weapon, was on trial. This science is called phenomenology. The phenomenologists had said that the atomic bomb would do terrible things. Joint Task Force No. 1 found that they were just about right.

Necessity had given birth to this science, secretly. Manhattan Project workers had not been certain what they were producing. Some thought the conversion of matter into

The submarine Skate looked crushed and worthless on July 2, but naval engineers said it could be ready for action in two weeks.

energy that they hoped to bring about over the enemy's heads would merely produce a tremendous burst of light, which might sunburn people severely but not do any "useful" damage. Others maintained that the atoms would release their energy in more effective ways. No one knew for sure. So jacks-of-all-sciences were assigned to solve this mystery, and were dubbed phenomenologists.

They had to assume that things that never had happened before would happen, and predict what else would happen.

Their predictions were only partially verified by the explosions at Alamogordo, Hiroshima and Nagasaki. In New Mexico, there weren't enough things in the bomb's way, nor was there time enough, for the technicians to determine its effects precisely. Nobody who knew an atomic bomb was coming, or how to measure its might, was in either Hiroshima or Nagasaki at the time those cities disappeared; and there was so much gore and wreckage later that only approximate measurements could be made. But at Bikini, everyone knew when and almost where the bomb would go off, and nobody got hurt. Hence, the phenomenologists' figures could be checked with greater accuracy than had been possible previously.

Gradations of Damage

Being human, phenomenologists could not always be right. One of them erred, in fact, at Bikini. It was his business to know what would occur before it occurred. But when a light shower fell on the observation ships, a few minutes after the first bomb went off, he wanted to run because he thought it might be radioactive rain. He was mistaken. It was harmless rain from a harmless cloud, which the meteorologists had seen coming, and they reassured him.

Despite this slip-up, the phenomenologists were pretty pleased with themselves the next day. Beautiful Kodachromes, which showed far more details of the explosion than any human eye had noted, were available then. And the flood of reports substantiated, in general, the phenomenologists' forecasts.

The 70 floating targets were the major part of the apparatus with which the predictions of the atomic scientists were checked. The ships had not been placed as they would be at a naval base or in a task force. They had been arrayed so that some would surely be sunk and others scarcely touched.

A line of attack transports, for example, extended from the battleship *Nevada,* the bombardier's aiming point, to the outer rim of the target. Anyone sailing along this line of ships the day after Test Able could see that these ships had been damaged to different degrees, and that engineers could readily draw a curve on graph paper indicating how seriously a ship at any given distance from an atomic bomb would probably be damaged.

The attack transport that was farthest from the bomb was only slightly scorched and damaged. The next one was more seared and battered; its stack was smashed in and its radar antenna was wrecked. The third attack transport in this line was really a mess; its bridge was gone, its superstructure crumpled, and it was still so "hot" when tested for radioactivity more than 24 hours after the bomb went off that it was dangerous to stay aboard it. The only signs of two other attack transports of the same type, which had been still closer to the bomb, were ugly smudges of smelly oil in the

Boarding parties (right), carrying Geiger counters, found some ships virtually intact and apparatus unharmed, yet dangerously radioactive.

A goat's cage was toasted black, but the goat broke out and survived the bomb's terrific blast.

lagoon's clear blue water. Divers descended later and found two big rips in the hull of the one that had been nearest to the bomb.

But the ships were only one part of the complex apparatus that was used to find out precisely what the bomb would do to what at what distance. The Army ordnance and materiel spread out on the decks, the panels of paint that resembled service ribbons on the superstructures, the animals in the gun turrets and the bottles left in the sick bays were also part of this supergauge. So much happens when an atomic bomb goes off that the instrument for testing its strength had to include all sorts of things.

Many of the devices set up on the ships were similar to those used to test such explosives as TNT and RDX, but they were spread out farther. An atomic bomb has been described as the equivalent of 20,000 tons of TNT, but some may explode more violently than others even though they come off the same assembly line. The technicians at Bikini were prepared for as great an explosion as 50,000 tons of TNT could produce.

Comparisons of atomic bombs and chemical bombs, however, are misleading. In addition to ordinary blast, heat and light, nuclear fission produces lethal radiation and radioactivity, which human beings cannot see, hear, feel, smell or taste. These phenomena were also measured at Bikini, but the gauging techniques and the findings regarding radiation will not be published. The radiation from the bomb does not continue long, but the radioactivity lingers, and even when exposure to this radioactivity is not fatal, it may destroy a man's white blood cells and expose him to other perils.

Although a man can see the light, and feel the heat and blast, these manifestations of nuclear energy are so great and brief that they seem almost as eerie as those that cannot be detected without instruments. The blast depressed the deck of the battleship *Nevada,* without harming delicate teletype apparatus resting on the deck. The heat left black, burned streaks across the floor of a goat's cage, but the goat was found casually munching hay. The light looked bigger and brighter than the sun, but men stared at it without goggles and were not blinded.

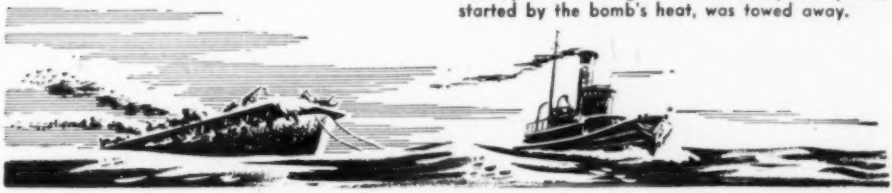
Amateurs Fooled

An atomic bomb, in short, behaves even more mysteriously than a Kansas tornado. Airplanes on the decks of target ships were torn to shreds, but drones flew right through the twisting cloud and were not even scorched. The upper part of the submarine *Skate* looked like a wad of wastepaper, crushed together by some unseen giant's fist, but the submarine still could cruise under its own power.

The staff phenomenologist for Operation Crossroads, borrowed from the Manhattan Engineering District, was Dr. Joseph O. Hirschfelder. He is a University of Wisconsin physicist and chemist. The forecasts which he and his associates prepared for Vice-Admiral W.H.P. Blandy before the bombs went off were revised frequently as more information was rounded up. Data obtained by setting off small charges of TNT in a model basin at Solomon, Md., for example, modified the official predictions regarding the column of water that would spout up in Test Baker.

Other prophets, without such up-to-date information at their fingertips, did not fare

The aircraft carrier *Independence,* her flight deck destroyed and bridge structure collapsed by fires started by the bomb's heat, was towed away.



so well. Many of them expected too much.

Compared to the forces that romp around and through the earth, the atomic bomb is a puny thing. Dropping one in the Pacific is about like dropping a welder's spark in a 30-acre lake. The Marshall Islands are a marshaling yard for the winds that create typhoons, but the forces that produce typhoons last much longer than those freed by the bomb. The air at Bikini on July 1 was full of moisture, yet the bomb's force was spent so swiftly that it did not even precipitate rain.

The alarmists were no more absurd, however, than those who pooh-poohed nuclear fission. There were officers at Bikini who chortled on the morning of July 1 because the spectacle, in bright sunlight, was not as awe-inspiring as it had seemed to the scientists who saw the first bomb explode on a dark night in New Mexico. These kibitzers crowed too soon that the damage was only superficial. Navy men wisecracked that only the "Army gear" had caught fire, and said the ships could be repaired in a jiffy. One observer, who had seen two of the three previous atomic explosions, had advised his friends to take a good look at the palm trees of Bikini on June 30, because they would be gone on July 1. The palm trees were not even singed, and this was cited instantly as evidence that the bomb was not as hot as advertised.

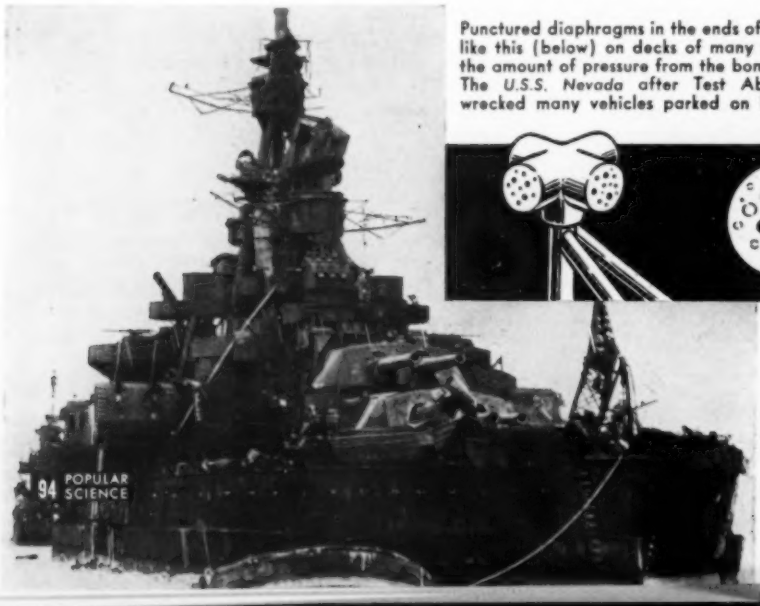
But the great fire on the aircraft carrier *Independence* lit the sky long after the sun had set. One whole side of the big red battleship *Nevada* was as black as toast even though the bomb had missed this brilliant target by at least a quarter of a mile.

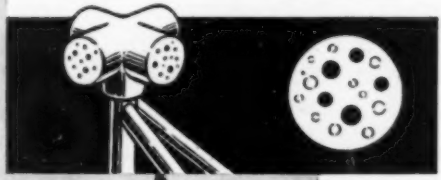
Never before had one bomb done so much damage to so many ships. Even things that seemed O.K. were useless. A concrete drydock, for example, looked the same the day after the bomb went off as it had the day before, but was so radioactive that no one could work on it and live.

The Bikini lagoon had been surveyed and studied so thoroughly beforehand that more was known about it than is known about New York's harbor, yet pools of radioactivity continued to bob up for days in places where they were not expected. Swimming at the Bikini beach was declared safe, then hazardous, then safe again. The line between inactive areas and zones of "hot" radioactivity was often amazingly narrow. Ship-boarding parties sometimes found one end of a vessel perfectly safe, but the other end so perilous that it had to be declared out of bounds.

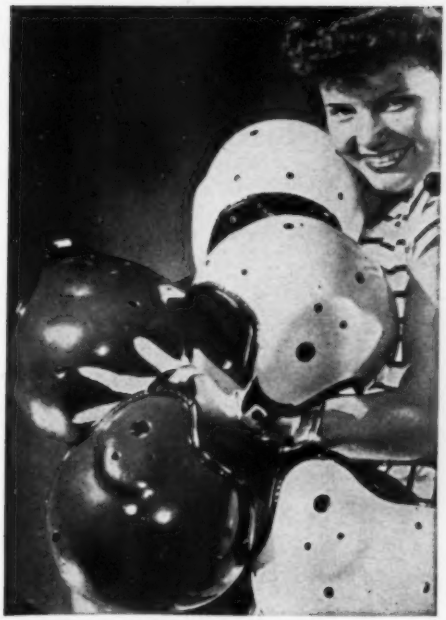
According to Rear Admiral Ralph A. Ofstie, of the U.S. Strategic Bombing Survey, it is absolutely impossible to say how many airplanes carrying chemical bombs would have been needed to knock out the fleet that was anchored at Bikini. One atomic bomb so reduced, blinded and lamed that fleet that for several days, at least, it would not have been worth much against even the Chinese Navy.

Official evaluators suggested almost immediately that superstructures should be redesigned. Future warships will not look like those now afloat. They may be much sturdier. But nobody knows how even an atom-proof ship can save a city from an atomic attacker's barrage.





Punctured diaphragms in the ends of pipes mounted like this (below) on decks of many ships indicated the amount of pressure from the bomb. Left, below: The *U.S.S. Nevada* after Test Able. The blast wrecked many vehicles parked on its deck.



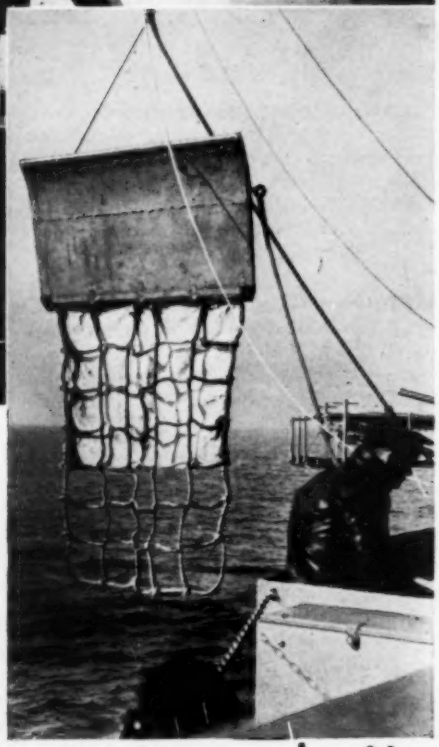
Plastic Football Helmets. Only half as heavy as the familiar leather-and-fiber helmets, these headgear are weather resistant and have as much or more protective strength. Made by MacGregor-Goldsmith, of Cincinnati, they are molded in one unit from phenolic laminated material.

Climbers for the Steelworker. Strapped over workers' shoes, these hard-rubber gripping spurs provide a safety measure for workers on vertical "H" or "I" beams. Wearer rests his weight on climbers, which grip the beam firmly. They're made by Austin Supply Co., Philadelphia.

Airborne Wire Recorder. What a flight instructor says to his student while aloft is recorded by the instrument below, at left, which is installed in the plane. At the right is the play-back unit. The system is sponsored by the C.A.A. to help standardize instruction methods.

LOOKING INTO THE SUN. This is possible with the Icaroscope, a telescope-like invention that enables the user to gaze at an exploding A-bomb (PSM, Aug. '46, p. 77) and other objects too bright to look at naturally. Developed at the University of Rochester to spot sun-hiding planes, it has a phosphorescent screen and metal shutters that darken very bright objects more than dimmer ones.

SCOUT PLANE GIVEN SLED RIDE. Returning scout planes to the mother ship by the U. S. Navy's "Charley Recovery" method is illustrated below and at right. A "sled" (right) is allowed to ride behind the ship, and the homing plane, with a minimum of jockeying, taxies onto the sled's nearly flat surface. It is then reeled into position under a crane that hoists it aboard.



PA-6 PIPER SKYSEDAN. Scheduled for 1947 production, this four-place, low-winged family plane is powered by a Continental 165-hp. engine with an electric starter and generator. Its 40-gallon fuel capacity gives it a range of 600 miles. Cruising speed tops 135 m.p.h.; landing gear is retractable.

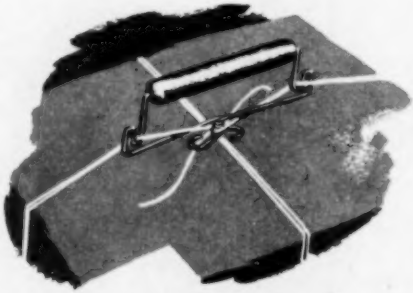
PIN UP

NEW IDEAS from the INVENTORS

Harvesting Basket Sits on Stick. Fruit picking is no longer a back-breaking job with the basket devised by A. F. Flournoy, Shreveport, La. A thumbscrew holds the container on the rod that runs through its center and is stuck in the ground, leaving both hands free to gather the crop and place it in the basket without stooping.

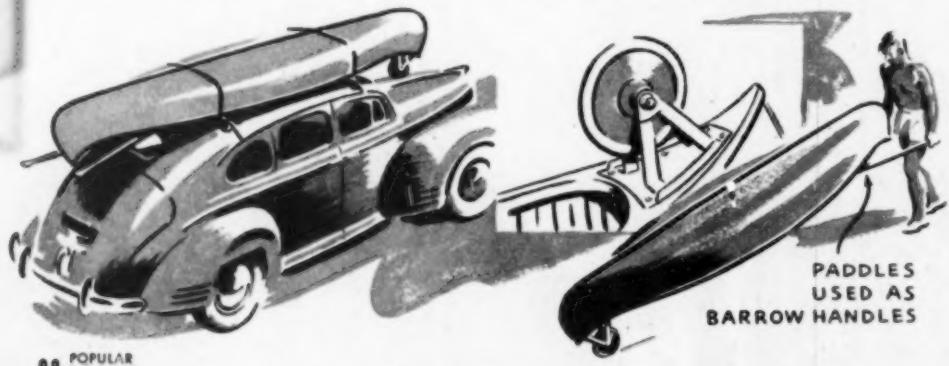
Golfer's Swivel Tee. Duffers and experts alike, who often have bent down to pick up tees after drives only to find they weren't there, should be glad to see the swivel tee (below), the idea of J. L. Paprocki, W. Islip, N. Y. It stays in the ground—unless you dig a big divot—and it won't break as readily as straight tee.

TEE SWIVELS WHEN BALL IS STRUCK



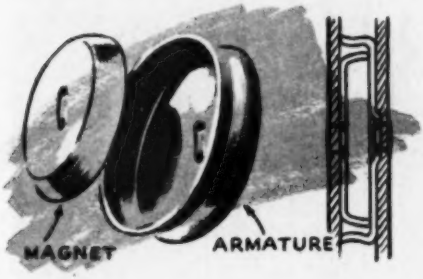
Ties Bundles Without Knots. A wooden carrying handle for packages, wired with twisted open ends at the bottom, makes it unnecessary to tie string or other binding. Hooked onto even a loose binding, a few twists anchor it securely without knots. Inventor is I. Raymond Trevisan, Newark, N. J.

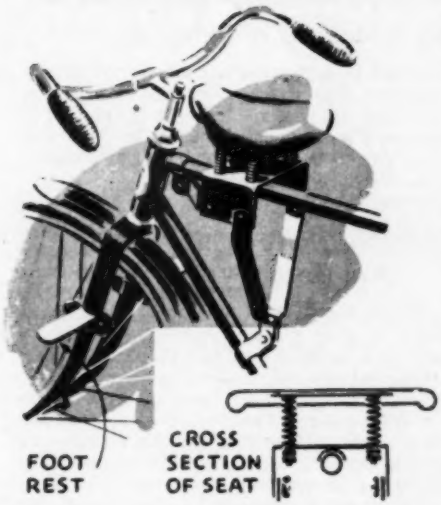
Rolling to the River. By providing a fixture on the bow to mount a wheel and brackets on the inner sides near the stern to take the paddles, a canoe or small rowboat can be quickly converted into a barrowlike device (below) that makes pushing the craft to the water an easy matter. Devised by A. A. Bjork, Ashland, Wis., this novel method also facilitates loading the craft on the roof of a car for long trips.



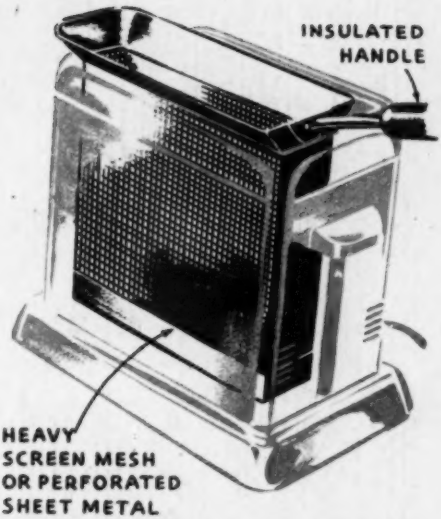
PADDLES USED AS BARROW HANDLES

Magnets for Buttons. Robert Ellis, York, Pa., has developed a magnetic button used in much the same way as ordinary snap fasteners. The smaller permanently magnetized part of the button is sewed to one edge of the material, while the armature of soft iron is fixed to the other. Fasteners are easily opened, and can be adapted to a variety of shapes and designs.



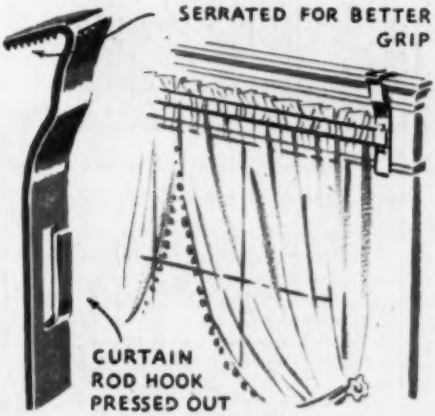


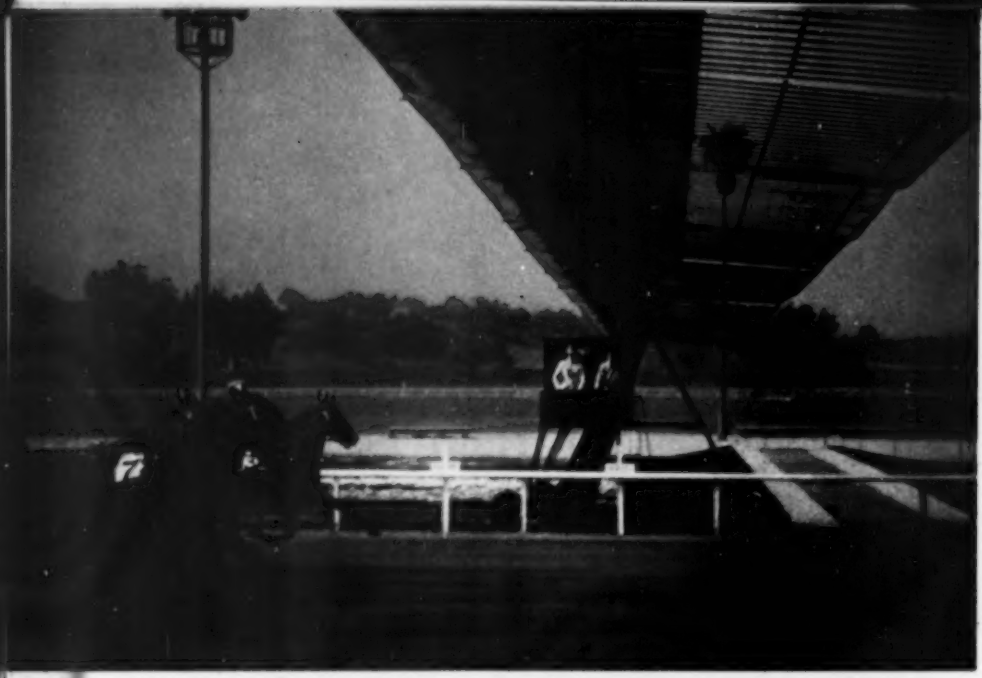
Bike Seat for Baby. Small youngsters will no doubt get all the thrills of bicycling from this front seat designed to go on Dad's machine. It is a saddle that is fixed by clamps to the crossbar just behind the handlebars. Comfort for the young rider is assured not only by well-arranged saddle springs, but by foot rests on the forward forks that can be adjusted to suit short legs. The seat, together with all the accessories for attaching and bracing it, is the invention of Herman K. Rehn, Amherst, Mass.



Crisps Cereal for Breakfast. Soggy cereal will regain its crispness in the container (above) designed by H. H. Buttner, Rye, N. Y. Shaped like a slice of bread and made to fit in either side of the average household toaster, it has an insulated handle for easy and safe lifting. For use with an automatic toaster, a hinged top may be added to hold in the cereal when the toaster pops.

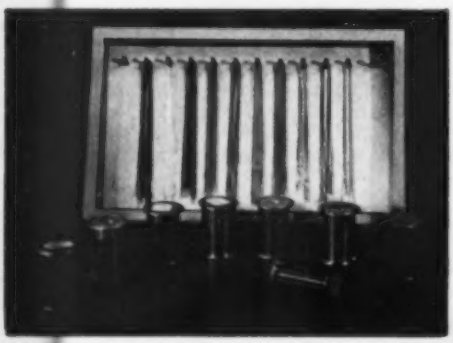
Makes Curtain-Hanging Easy. A strip of metal ½-inch wide and 1/32-inch thick has been devised by Morris S. Licht, Cleveland, Ohio, for hanging curtains on rods without the aid of other fixtures. The flat metal piece is bent to hook over the top window molding, and a curtain-rod hook is punched out of its lower end. No nails or screws are needed.





Moving Barrier Paces Trotting Racers to a Getaway

THEY'RE OFF to a good start in sulky races when this new mobile starting gate is used. Designed by Walter E. Smith, harness racing official, it is made of tubular-steel grillwork, rolls along on rubber-tired wheels, has 11 eight-foot-wide stalls, and is powered by a gasoline motor. As the horses approach, the gate moves ahead of them until they are well lined up. Then the starter presses a button, springing the barriers upward (as above), and giving a 12-foot clearance for horses and carts.

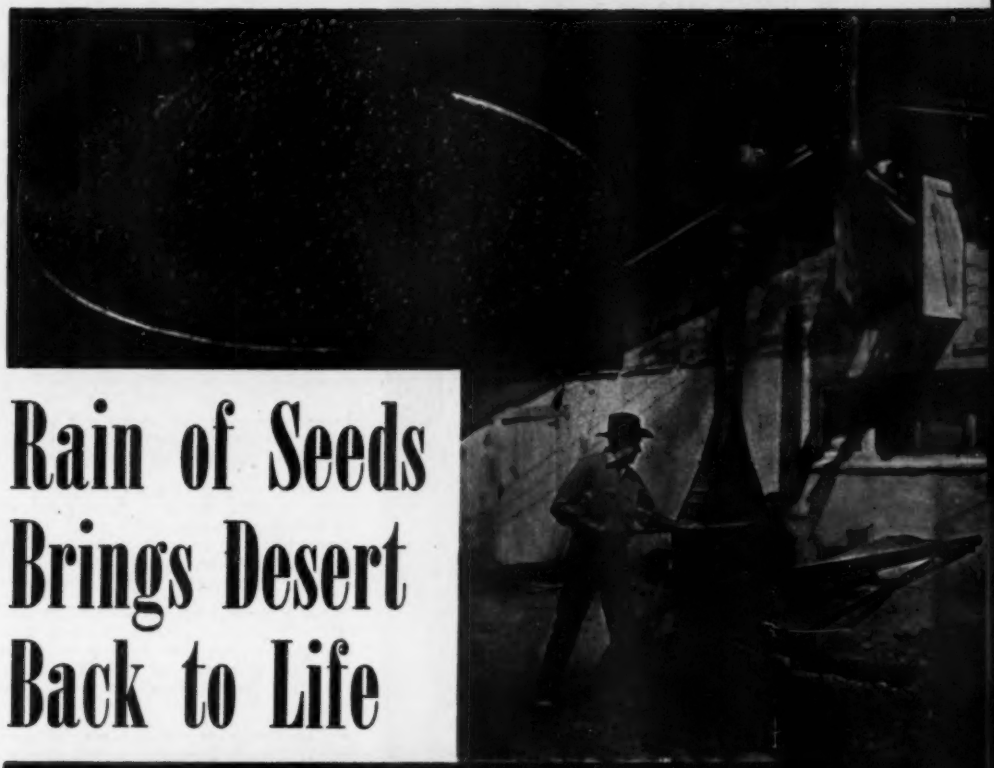


New Trimming for Dresses Stems from Navy Braid

WITH experience gained by having made miles of gold and silver wire for Navy uniform braid during the war, North American Phillips Co., Inc., was able to develop the colored coating on hairlike wires shown above. It is used for glamorizing women's dresses and accessories.

Plastic Phonograph Records Are Decorated in Color

APPROPRIATE color pictures adorn both sides of new plastic phonograph records, made by Vogue Recording Co., Inc., of Detroit, that not only outlast ordinary shellac records but may be put up in the game room or children's room as decorations. A noiseless, super-high-fidelity plastic surface on an aluminum core prevents them from breaking or warping and gives true tone without needle scratch.



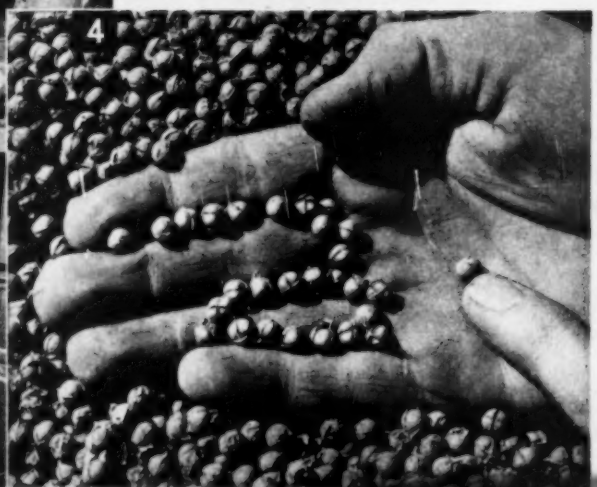
Rain of Seeds Brings Desert Back to Life

Factory-made pellets, sown by plane, grow grass in Southwest.

Above: Millions of these pea-sized pellets, loaded with love-grass seed (*Eragrostis*), are being sprayed on the denuded range lands of the Papago Indian Reservation, Arizona, to revive that area for agriculture and stock raising. Besides the grass seed, each pellet contains a rodent- and insect-repellent, fertilizing agents, and is chemically treated to prevent mold and deterioration.

At right above: Clay-type soil, brought to the pellet-making factory from the land where the planting is to be done, is first run through a hammer mill, which pounds it into a fine powder. This powder is blown through a pipe up to a hopper above the mixing machinery, then fed by gravity through the pellet-making apparatus until it comes out in tiny balls ready for planting.

At right: Dr. Lytle S. Adams (right) and Pilot A. R. Brown survey the map of the area to be planted prior to the initial take-off on the first flight to bring new life to the western range. Dr. Adams, early aviation enthusiast and inventor of the air-mail pickup, directs replanting projects for the Departments of Agriculture and Interior.



1. Dr. Adams inspects a stand of love grass in a test plot set out on the Papago Indian Reservation a year ago in the search for a grass especially suited to the dry areas of the West. This experimental plot is among the 50,000 acres being planted with the pellets containing love-grass seed, found most suitable, which had to be imported from Africa.

2. Pouring a bucket full of the grass seed into a hopper above a mixing machine; through the larger hopper at the left is run the pulverized clay. Fed by gravity into the machine in correct proportion, the ingredients pass through a series of rotating blades on a shaft, insuring a uniform mixing of the seeds through the moistened, treated soil. This mixture then falls between recessed disks, where it is pressed into uniform-size pellets that drop into containers, ready to be planted.

3. Three pellet-making machines are already in operation at a factory set up in Sells, Ariz., headquarters of the Indian reservation. In an eight-hour day they turn out 18,000 pounds of pellets, enough to plant 4,500 acres.

4. Looking like miniature walnuts, the pellets will germinate within 48 hours after sufficient rainfall. Their firmness facilitates handling, planting, and ground penetration, and gives protection until the seed sprouts.

5. The amount of acreage planted each day is directly controlled by the carrying capacity of the plane, the distance of the airstrip from the acreage to be planted, and the time it takes to load the pellets into the plane. To speed up this last operation, a small, farm-type tractor was fitted with a hydraulic lift equipped with a special extension yoke and a hopper that holds the same amount of pellets as the hopper in the plane. The reseeding plan in the Sells vicinity will bring much employment to the Papago Indians, whose prime interests for centuries have been

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agriculture and stock raising. Other tribes in the West and Southwest will also benefit from government-sponsored planting.

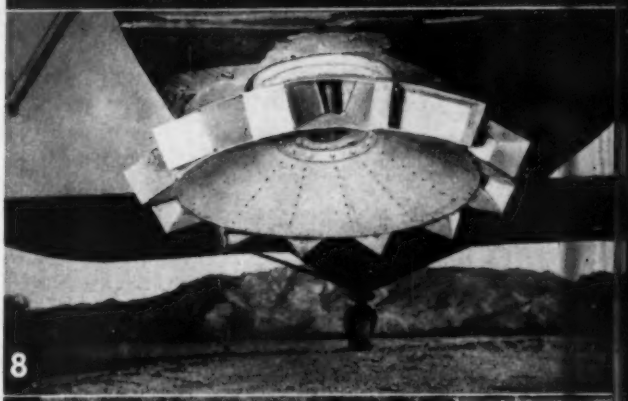
6. A loading hopper moves into position above the plane and a Papago Indian releases the seed into the aircraft. This fast-loading idea reduces the time a plane must be grounded.

7. Flying at 500 feet, a Bellanca Pacemaker spills out the seed pellets through a disseminator on the underside about midships. The ship has a safe-load capacity of 1,500 pounds of pellets, which will plant an area 250 feet wide by two miles long—an average of one pellet to every square foot of ground.

8. The disseminator, connected to the hopper by a gate controlled by the pilot, has 12 wind vanes. Centrifugal action sprays the pellets in an even pattern. An auxiliary motor coupled to the shaft of the disseminator insures uniform operation under varying conditions of wind action and load drag of the pellets coming down through the hopper. With ideal flying conditions, 2,000 acres are seeded in a day.

9. This blanket test proves the efficiency of the Sky Planter. Stretched taut as the plane flies overhead, it is pelted with the accuracy of a shotgun.

10. Sky planting is not new. It was done as early as 1924 by Glenn Curtiss, pioneer flier and airplane maker, who sowed grass seed by plane over the Florida Everglades.



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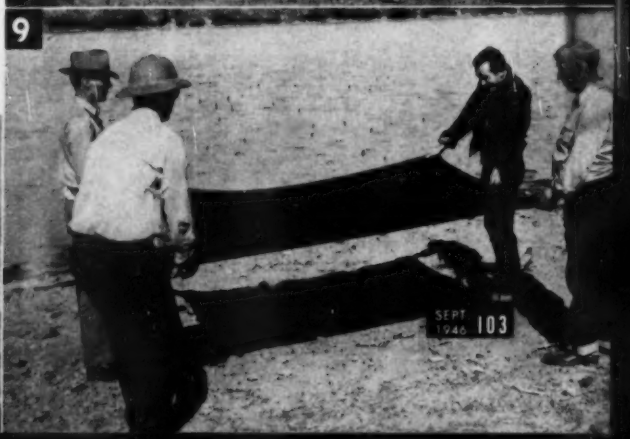

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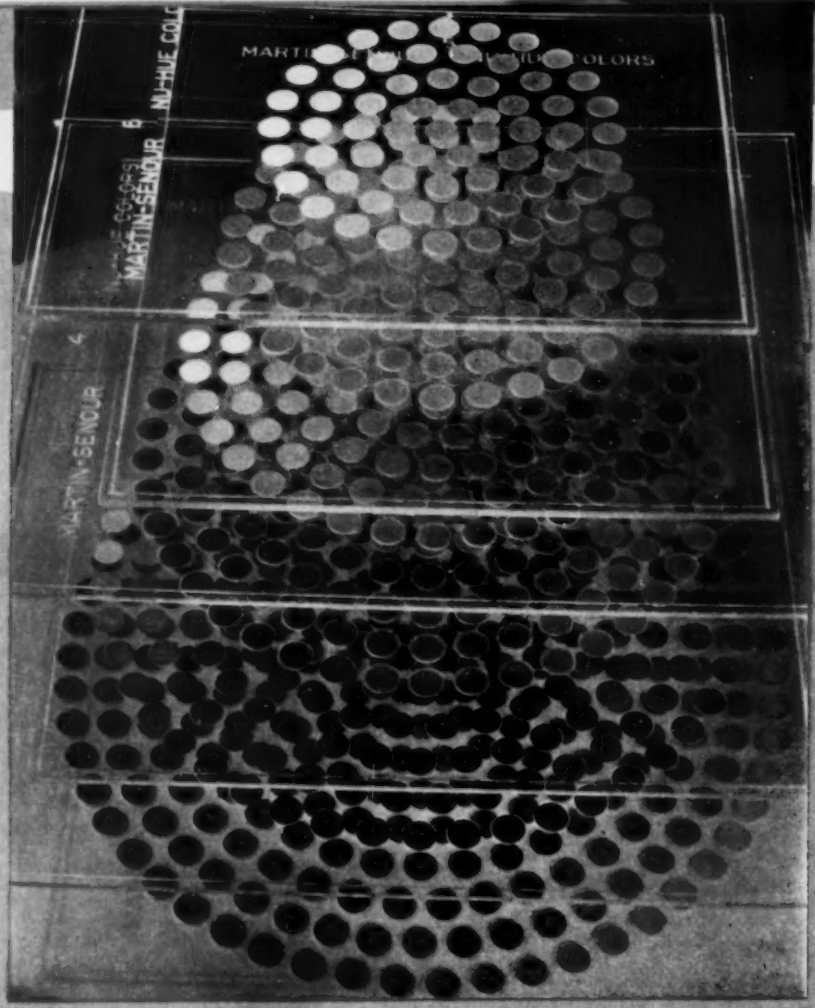


2 Nine plastic plates contain 1,000 color chips, arranged in the order of the spectrum. The first plate's colors are most intense; the others display lighter tints. Each plate is a standard color wheel.

Photographed at W. & J. SLOANE by PSM Photographers

3 A code number on the back of each chip gives the key to finding its formula in the directory, provides data for custom-mixing.

4 The card-type directory has paint swatches of all the colors, also arranged in spectral order, with the formulas printed on them. Then it is simply a matter of measuring and mixing.

1 Selection of exactly the right matching or complementary color is made easy with Nu-Hue Custom Color charts. The transparent plastic sheets with painted chips embedded in them may be brought into the home and placed over any fabric, painted surface, or furniture.

Color Mixing That Can't Miss

With 12 ingredients, a paint dealer now can reproduce any one of 1,000 colors exactly in a few minutes.

GUESSWORK has been eliminated from paint mixing by a scientific system that gives each of 1,000 colors a number of its own and provides a foolproof formula for reproducing it. With the initial help of a novel paint chart on plastic, a paint dealer using the Nu-Hue system, recently developed by The Martin-Senour Company, can quickly reproduce any of the 1,000 colors from a stock of only 12 ingredients.

Nu-Hue utilizes six colors—red, yellow, orange, purple, blue, and green—plus neutral gray, white, an oil or some other extender, and a varnish. The colors were selected on the basis of what they do when combined, not what they are when used alone. Combining one or more of them with gray and white produces any desired color. And the formulas provide unvarying results after the paint is dry. They can be used to produce any type of coating from flat to high-gloss.

5 For the paint dealer who handles a large volume of business, a dispenser for the colors and other ingredients has been designed. With a maximum of 12 containers and the formulas from the color directory, the dealer is then equipped to produce any color in the time it takes to stir paint before using.

I'd like to see them make

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.

Fountain-Pen Anchor. Something besides a mere clip that will really make a fountain pen cling to your pocket. Richard Klein, Cudahy, Wis., suggested it.

Transparent Posts. Basketball fans ought not to have to peer around pillars, so Jack Waite, Greenville, Pa., recommends making gym supports of plastic or glass.

Passenger-Shifting Bus. For bus riders who linger near the front, Peter Ferko, Bridgeport, Conn., suggests the above method of urging them to the rear.

Ring-Free Bathtub. Just install a sprinkler system around the top of the tub, so that ring would be washed off, says Mrs. Ruth Keefer, Anaheim, Calif.

Sign to Signal Trolley Stops. It would flash a warning to trolley riders at night when they are due to get off. Idea is from Sylvia C. Schneider, Biwabik, Minn.

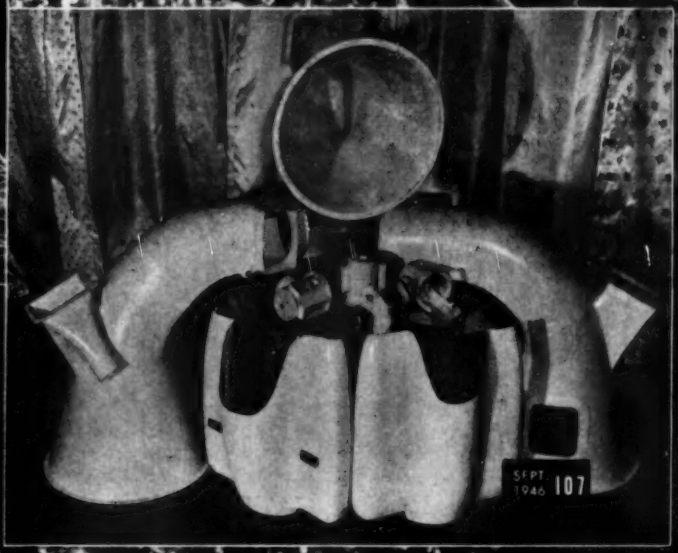
Color Scheme for Keys. Louis Singer, St. Louis, Mo., would like to see them make keys and locks with color symbols to match, for easy identification.

Cartoons by SYD LANDI

New Jobs for GLASS

Stronger-than-steel fibers serve fliers, motorists, engineers, sportsmen, housewives.

WHEN glass is blown into fibers the size of the strands of a spider web it becomes as flexible as cotton thread and stronger than steel. No longer a novelty, this process was first used commercially in 1931. Since then, Fiberglas has been given more than 4,000 jobs to do in American industry and is daily being put to work at new ones, some of which are shown here. Engineers and designers think this is only a beginning for a material that does not burn, shrink, stretch, oxidize, rot or rust, and is not harmed by weak alkalis or most acids.



The light, flexible fishing rod above is made of glass fibers bonded with plastic, yet it is stronger than a bamboo rod and does not develop a "set." Laminated Fiberglas parts (right) for combat planes, proved out during the war, also combine lightness with stamina. Glass is cast into spheres (top of page) before it is made into fibers.

Kodachromes by Jerry Fairbanks from *Popular Science on the Screen*

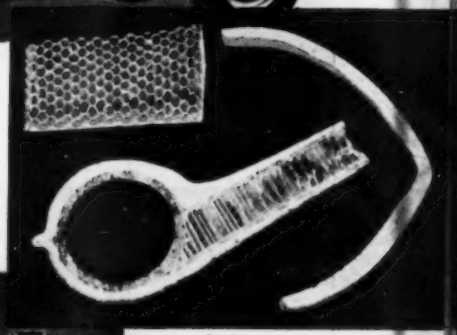
On a glass ironing board, this woman is pressing her glass frock. The material will not burn, and a hot flatiron, left on it while the user answers a telephone call, will not even leave a scorch mark. Window and door drapes are also made of the Fiberglas fabric.

Steam pipes at left are insulated with "wool" made up of countless interlaced glass fibers. Besides being one of the best insulators, Fiberglas does not rust or decay when laid underground.

The home-type hot-water storage tank below is being covered with glass-wool insulation. Myriads of air pockets in the material prevent the escape of heat from the water.

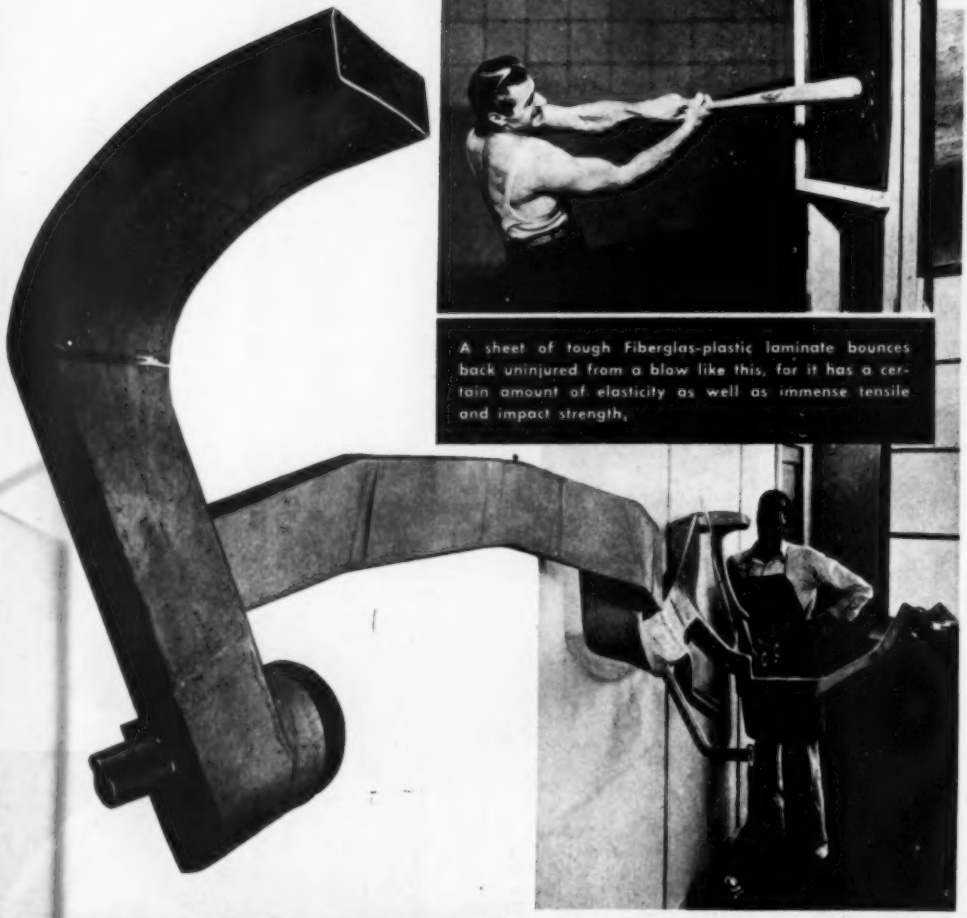
Glass-clad models watch the flames of a burning wastebasket lick harmlessly at curtains woven of glass fibers. Though this new textile material does not burn, it nevertheless will melt if the temperature goes high enough.

The body of this car, designed by William B. Stout (PSM, July '46, p. 84), together with the bumper and a few structural parts, is made of Fiberglas bonded with synthetic resin. News writers, invited to hit the body with hammers, found they could not dent it. Shown right are cross sections of the bumper and a hollow strut that attaches the engine to the body; also a cut-away piece of the Fiberglas honeycomb material that is used to make the interior of the strut.



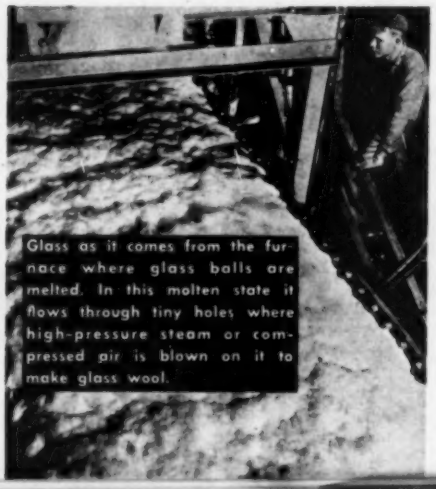
The filling of this downy comforter is fleecy glass wool, while the cover is a finely woven glass textile similar to that used in 14 plies to make the automobile bumper shown in the above photograph.

A sheet of tough Fiberglas-plastic laminate bounces back uninjured from a blow like this, for it has a certain amount of elasticity as well as immense tensile and impact strength.

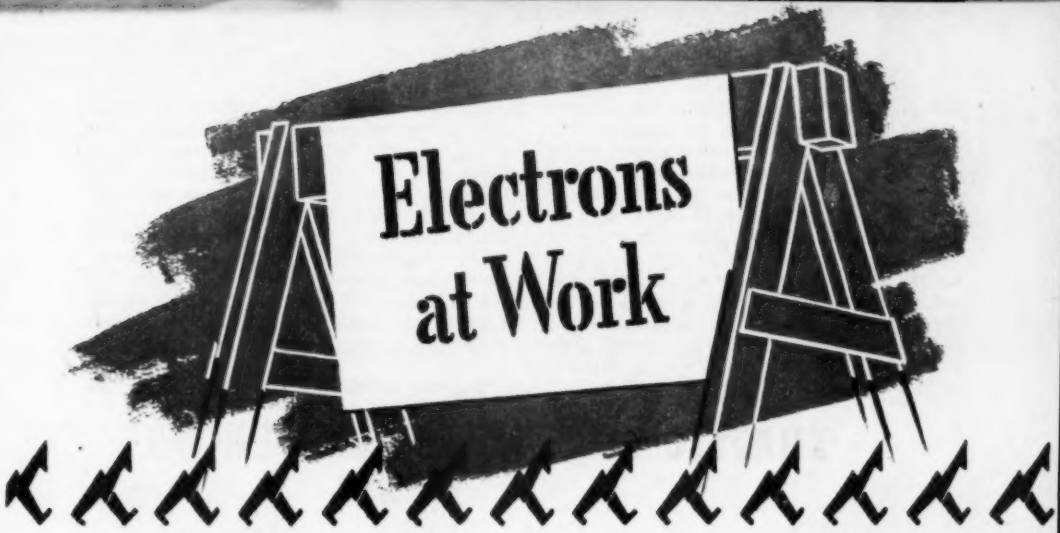


Fiberglas won respect as a structural material by proving its worth in complicated airplane parts like this queer-shaped air duct. Peace has lifted the wartime ban on some 300 research projects devoted to finding new commercial uses for glass.

Greatest present use of glass fiber is for insulation against noise and heat. Airplane interior (below) is being blanketed with the material. Fibers in new acoustic insulation are 5/100,000-inch thick.



Glass as it comes from the furnace where glass balls are melted. In this molten state it flows through tiny holes where high-pressure steam or compressed air is blown on it to make glass wool.



How the busy family of vacuum tubes serves industry as valves, triggers and throttles of electric power.

By WILLIAM P. VOGEL, JR.

WHEN you snap your radio on; when you cross the path of an electric eye and untended doors jerk open to let you pass; when you hear your train called with strident clarity above the clamor of a vast terminal, electrons have been put to work.

Electrons are controlled by vacuum tubes. And vacuum tubes in the last 15 years have gone far afield from their original uses in communications to become the valves, triggers, and throttles of modern industry.

All vacuum tubes, from the tiny nutlike affairs in hearing-aid devices to the six-foot water-cooled giants used to handle hundreds of kilowatts in radio broadcasting and power conversion, depend upon the same principle. This principle is that electrons—those ultimate bits of electrical energy—can be rapidly and automatically controlled when they are freed from a metal conductor and jump across the empty space inside the tube. Their behavior during those microseconds can be changed in almost any way that human intelligence wants it to be changed.

Attempts to classify vacuum tubes began almost immediately after Dr. Lee DeForest invented the basic three-element tube in 1906, which he termed the "audion." The late Dr. Michael Pupin, of Columbia University, objected to the name, saying it was a "mongrel . . . a Latin word with a Greek ending." Soon afterward, Dr. Irving Langmuir, of the General Electric Company at Schenectady, began to refer to two-element tubes as "kenotrons" and three-element tubes as "pliotrons." Dr. DeForest scoffingly termed this jargon "Graeco-Schenectady." Yet, today the electronic scene is full of ignitrons, phanotrons, thyratrons, magnetrons and such trademarked items as Radiotrons. But don't let the long words scare you: *what* electrons-at-work do is fairly simple, even if we don't always know *how* they do it.

No matter how big or how small, whether for microwave work or to control the split-second cycle in resistance welding, all vacuum tubes must have cathodes—the source of the electron stream. There are many different types of cathodes. Some are simply filaments, very much like the glowing wire in the ordinary incandescent lamp. When an electric current heats the filament to incandescence, electrons are boiled out of it much as steam is boiled out of water. Another type of hot cathode is built like a tiny electric stove, with an electric heating coil inside the cathode sleeve. Some vacuum tubes have cold cathodes, in which the electrons are literally pulled out of the cathode material by a high voltage across the tube. An important class of tubes, known as ignitrons, have pools of mercury as cathodes, from which the electronic stream is started by an auxiliary electrode called the ignitor. Phototubes, widely used to measure paper thickness, to keep color plates in register on the printing press, and to open and close doors, have yet another type of cathode—one from which the elec-

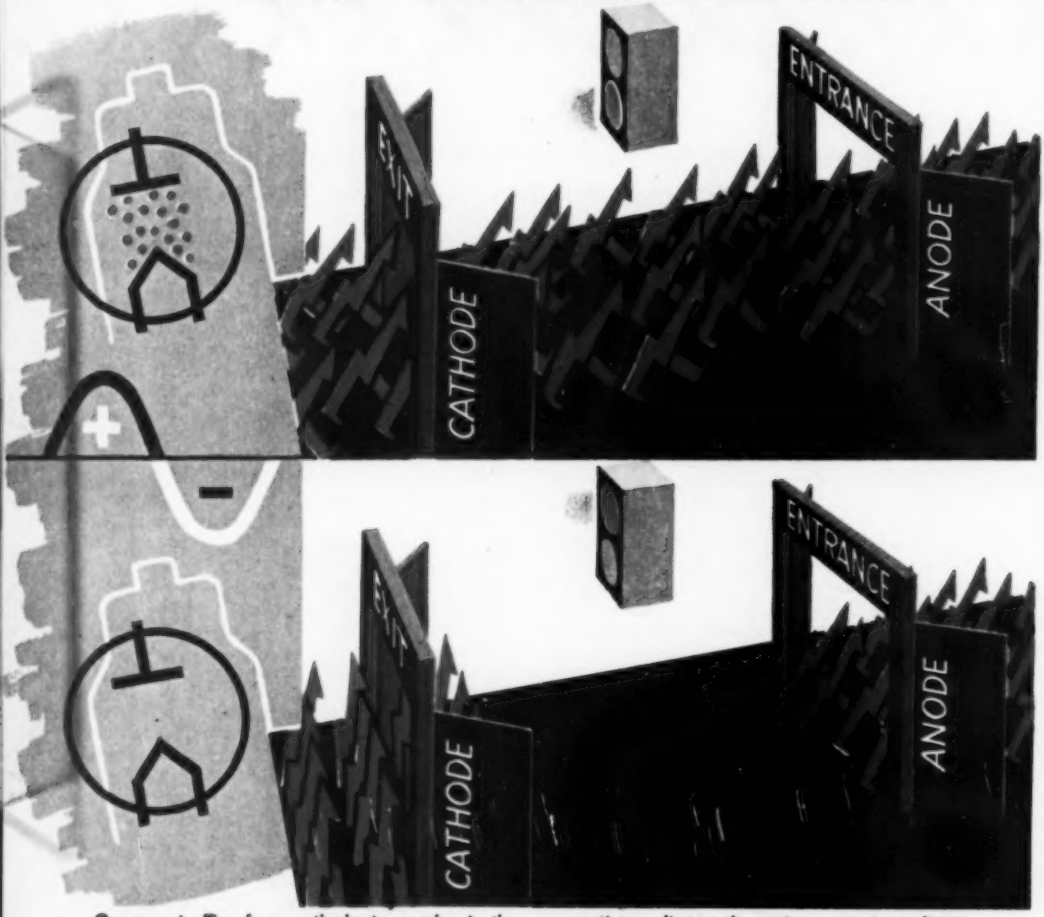
trons dart out in proportion to the intensity of the light falling upon the cathode.

Another essential for vacuum-tube operation is the anode—the collector or receiver of the electrons emitted by the cathode. The anodes are always positive with respect to the cathodes—ranging from a mere 90 volts or so on the anode (familiarly known as the "plate") in a small household radio tube to many thousands of volts on the big water-cooled anode of an industrial or transmitting tube. The anode can never emit electrons—that is the special privilege of the cathode.

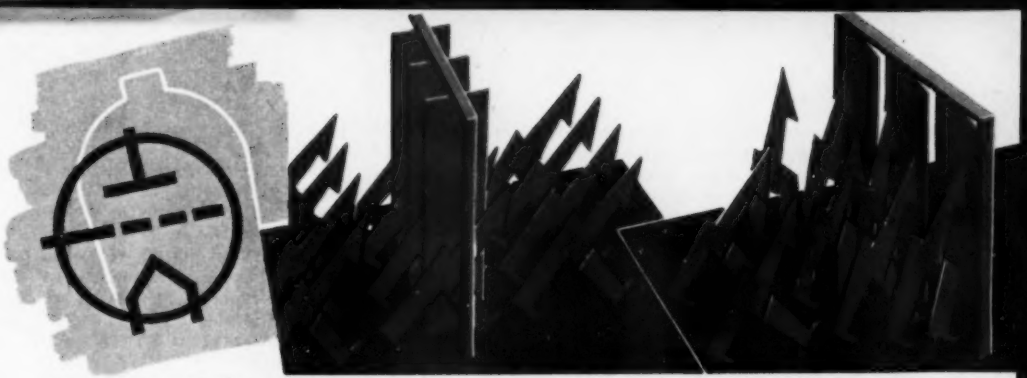
Because of the unique behavior of these two electrodes, vacuum tubes acquire one of their most important characteristics: they act as valves. The current flow through the tube can be in one direction only, from cathode to anode. This makes the two-element tube—the kenotron—a natural for rectifying alternating current into direct current. And in radio applications, kenotrons, commonly called diodes, apply their valve action as well to such jobs as detection and automatic volume control.

But the kenotron has its limitations. Be-

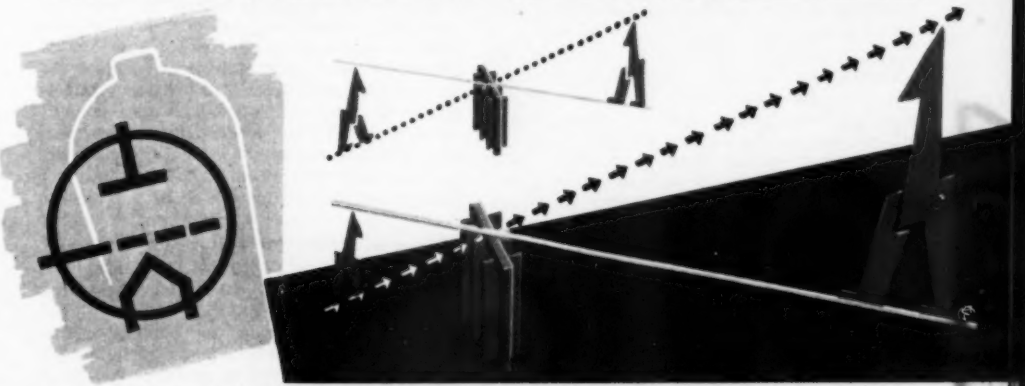
TRAFFIC CONTROL OF ELECTRONS



One-way traffic—from cathode to anode—is the inflexible law of electrons. The kenotron (symbolized at left) is a simple, two-element vacuum tube that stops that traffic 60 times a second while converting ordinary alternating current to direct, as the above panels illustrate. But traffic in the kenotron tends to jam around the cathode as the impeding "space charge" develops.



By setting a grid, like a shuttered gate, between cathode and anode, the space charge can be dispersed at will. As the grid's charge, which can be varied, becomes more positive it speeds the electrons on their way (center, above). The more negative it is the more it congests traffic. Symbol at left is that of the pliotron, simply a kenotron with the grid added, which is used to control and amplify.



An uneven seesaw best illustrates how the grid enables a vacuum tube to amplify impulses. When the grid is placed close to the cathode, a *slight* change in grid potential controls a *large* change in the flow of electrons to the anode, just as a small movement of the short end of the seesaw causes a large movement of the long end. This effect is lost when the grid is centered, as seesaw in background shows.

The traffic-hampering space charge is eliminated altogether in the phanotron (symbol at left), which is a kenotron into which a small amount of inert gas has been inserted. As the gas becomes ionized its molecules become positive and pull electrons out of the space-charge region very much the way a special squad of traffic cops speeds a clutter of cars through a busy intersection.

cause the negative electrons tend to pile up around their source, the cathode, they get in the way of other electrons traveling to the anode. This is known as the space charge. To overcome the crowding, a tiny quantity of some gas such as mercury vapor, argon or xenon is placed in the tube. The gas overcomes the crowding action of the electrons and hustles them on to the anode. The gas acts in this way because it becomes ionized—by losing electrons its molecules become positive and attract new electrons from the cathode, which in turn are knocked out by others as the rate of flow increases. Such gas-filled tubes are called phanotrons; they have the ability of handling greater quantities of current than kenotrons.

A third class of rectifiers is the ignitrons. Because their cathodes are pools of mercury they have tremendous power-handling ability. Despite the ignitor, which starts the action of the tube, they are basically two-element tubes like kenotrons and phanotrons. As the ignitor fires the cathode, vast quantities of electrons pour out of the pool toward the anode. At the same time quantities of positive mercury-vapor ions are created, which, as in the phanotron, serve as traffic cops to help the electrons on their pell-mell course to the anode. The biggest ignitrons can deliver 200 amperes of current at 20,000 volts—a power output of 4,000 kilowatts, more than enough to make a typical small town shine like Times Square on New Year's Eve.

Tubes That Control and Amplify

The space charge can be put to work by adding a third element, called the grid, to a vacuum tube. When a grid, deliberately made negative, is placed between cathode and anode, it will hold up current flow just the way the space charge does. But if the grid becomes more positive, it will aid the flow of electrons to the plate the way the positive ions in the gas-filled tubes do. With the introduction of the grid, vacuum tubes acquire two more characteristics: control and amplification. If two-element tubes act like one-way check valves, then three-element tubes act like triggers or throttles.

Tubes with grids belong to two families: the pliotrons and the thyratrons. The pliotrons are high-vacuum tubes, like the kenotrons. The thyratrons, like the phanotrons, contain minute quantities of easily ionized gas. Most radio-receiving tubes, except rectifiers, belong to the pliotron family, while the thyratrons find their biggest application in industry.

With the pliotrons, the vacuum tube assumes its function as a throttle. Suppose the grid is made quite negative. The electrons, crowding away from the cathode, are stopped dead in their tracks by the negative grid, very much the way a closed Venetian blind keeps out light. Now, as the signal varies and the grid becomes less negative, it permits more and yet more electrons to flow to the plate. Plate current increases. The Venetian blind is now open, admitting full sunlight.

In the thyratrons the action of the grid is more like a trigger than a throttle. Like all gas-filled tubes, thyratrons can handle larger current flows. When the grid is negative the current is halted, but once the tube has started to pass current the grid becomes ineffective, because of the ions of gas that jostle the electrons on toward the anode. The only way a thyratron, once it has been "fired," will cease to pass current is to make the anode negative. This permits the gas inside the tube to "deionize," and the grid once more takes command of the electron stream.

"Seesaw" Effect on Volume

In both types of tubes any degree of amplification can be obtained, depending upon tube design. If the grid is placed very near the cathode, as it usually is, it becomes possible for a small change in grid potential to control a large change in plate current. Suppose that a change of one volt in the grid potential causes a change of 15 volts in the plate potential. Then the tube is said to have an amplification factor (designated by the Greek letter *mu*) of 15.

In certain classes of pliotrons and thyratrons voltage gain is sacrificed in favor of power-handling abilities. Again the designers space the electrodes in such a way that while the grid voltage does not produce a significant change in the plate voltage, the tube permits a large number of electrons to pour into the anode. Such tubes are called power amplifiers and their most familiar use is in the amplifiers used to drive a loudspeaker of a radio installation or a public-address system.

Because of the control and amplifying action of pliotrons and thyratrons you can obtain whatever effect you want. All you have to do is to choose your tubes properly. You can magnify the tiny impulses of electricity produced by your brain or your blood stream to power a stylus that draws an encephalogram or a cardiogram—or you can automatically drive heavy switchgear or work the loudspeakers in Madison Square Garden.

It Helps to Add a Screen

Like all other vacuum tubes, tubes with grids have certain limitations. The anode and grid oppose each other—for that reason, when we want maximum power in the load, we have to make the anode least able to attract electrons by making it less positive. Likewise, when we want less power in the load, we have to make the anode more positive, just at the time when we want reduced current flow. The best way to overcome this is to insert a second grid, called the screen, between the control grid and the anode. The screen is made positive. Thus the twin functions of the anode are split between two electrodes: the screen attracts and accelerates the electrons while the anode collects them. Even the screen has its limitations. Some of the slower electrons fail to get to the cathode and tend to return to the positive screen. To prevent the return of these electrons, still another grid, known as the suppressor, is inserted in the tube between the screen and the anode. Carrying a negative charge, the suppressor repels electrons that would like to go to the screen and hustles them on to the anode.

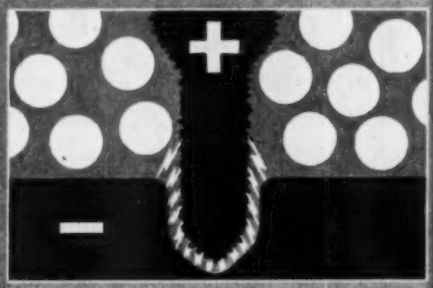
And On Up to "Hoptoads"

Tubes with three elements are commonly called triodes, those with four are called tetrodes, and those with five are called pentodes. Special radio and industrial tubes, in which several different tube types are enclosed in the same container, have as many as six, seven and eight elements and are called hexodes, heptodes and octodes. Among vacuum-tube designers there is frequent joking about a mythical tube known as the "hoptoad"—which, if it could ever be built, would have an infinite number of electrodes and the ability to perform any function whatsoever without loss or limitation.

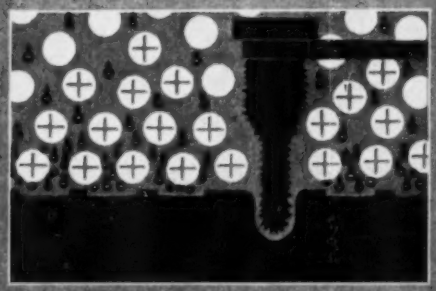
In general, all of the ordinary tubes used in radio, telephony, and industry are of the types described. There are many varieties of tubes, each with different characteristics and different circuit applications. The electronic engineer simply has to pick the right tube for his purpose. For example, a radio set could be built using only diodes and triodes. But the diodes used to rectify house current would be far larger tubes than those used to detect the signal. And the triodes used for voltage amplification would be far different from the triodes used to drive and supply power to the loudspeaker system.

As the electronic industry challenged the unknown region in the higher reaches of the radio spectrum—where the frequency is 300 megacycles and more—it became evident that a totally new kind of thinking about vacuum tubes was necessary. No longer could the tube be considered merely the electronic component of a circuit composed of conventional inductances, capaci-

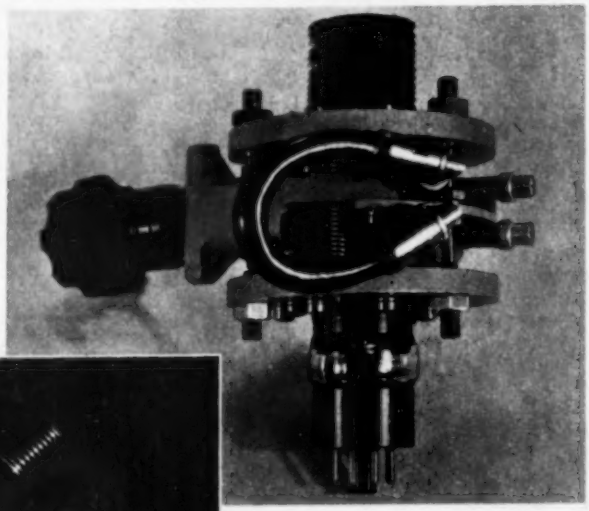
1. The ignitron looks more like a gleaming section of steel pipe than a conventional vacuum tube. It is used in resistance welding, where heavy current flow is needed. Its cathode is a pool of mercury (above, right). An igniter of semiconducting material dips into the pool, its rough surface making poor electrical contact with the mercury.



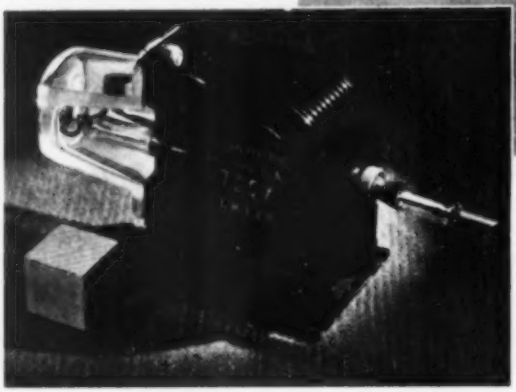
2. When a positive voltage is applied momentarily to the igniter (above), tiny arcs along its surface start electrons surging to the anode, ionizing mercury vapor atoms (below) to speed the rush.



The lighthouse tube (left) does the same job that an ordinary radio tube does, except that it performs in waves so short that the size of the tube itself and its elements affect the operation. In the lighthouse tube only a few millimeters of space separate the cathode, grid and anode. And the space surrounding them is used in the way that conventional capacitances, resistances and inductances are used for the standard broadcast band. In general, the microwave tubes generate frequencies so high that they no longer can be conducted by wires or tuned by ordinary condenser-coil assemblies. The waves have to travel like fluids through hollow wave guides.



The klystron (right) of radar fame passes an intense beam of electrons from the cathode through a grid called the buncher, which varies the flow according to plan. Near the anode, a second grid, the catcher, interprets the impulses, amplifies and sends them on to high-powered oscillators.



In the magnetron (left), electrons are whirled about an axial cathode by an electro-magnetic field and allowed to strike the anode with tremendous force. The magnetron, like the klystron, is capable of enormous power output. It gets extremely hot even when operated for a millionth of a second, and is usually encased in a water jacket.

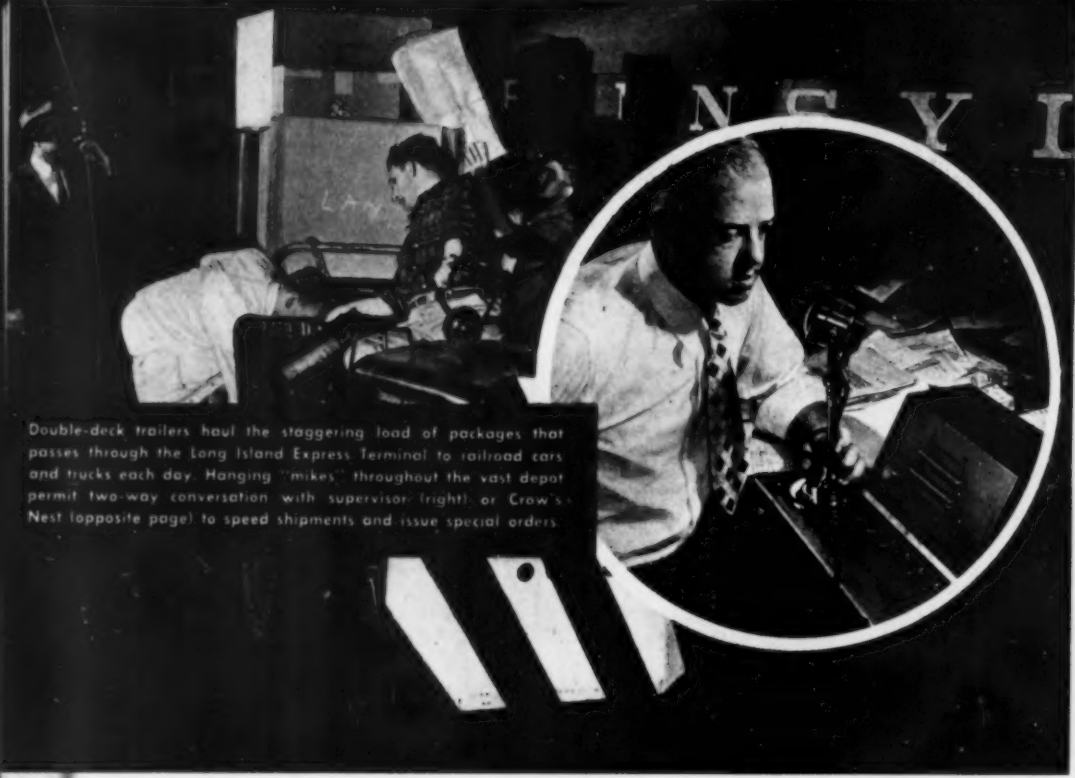
tors and resistances. As the wave lengths in this microwave region became comparable with the size of the tube, such new factors as the transit time of electrons from cathode to anode, the radiation through the tube itself, and the losses from leads became vitally important to performance. With the tremendous research on radar during the war, such problems were faced and successfully solved. Philosophically, vacuum tubes for this microwave range began to be considered as simply a walled-off section of a complete electrical system. Such tubes as the velocity modulators, of which the klystron is the best-known example; the disk-seal tubes, of which the lighthouse tubes are the most familiar; and the magnetrons were developed. In these tubes the whole oscillating system is usually built into and around the tube. In certain cases the tube and its system can be used as a plug into the radio-frequency source, much the way a lamp cord can be plugged into a house-current receptacle.

These strides have been important—but they have by no means exhausted the possibilities of vacuum tubes. As new uses are demanded, new tubes will be forthcoming. Even as the modern radio tubes of today are a far cry from Dr. DeForest's first audion, so are the tubes on the drawing boards far different from the most outlandish magnetrons and klystrons of the war period. Because the principles of vacuum tubes are now so well understood, there is no challenge that the tube designers feel they cannot accept.

Comparative size of an ordinary radio tube

Above is the first color photograph ever taken of a grid-controlled thyratron being drained of its air and residual gases prior to use as a "trigger" of industry. The encircling black bars form a high-frequency induction coil, which heats the tube elements until they glow red, to drive out gas held in solution. The gas turns blue because it is being ionized by a high potential between cathode and anode.

PSM Kodachrome
by WILLIAM W. MORRIS



Double-deck trailers haul the staggering load of packages that passes through the Long Island Express Terminal to railroad cars and trucks each day. Hanging "mikes" throughout the vast depot permit two-way conversation with supervisor (right), or Crow's Nest (opposite page) to speed shipments and issue special orders.

Fingertip Control of World's Biggest Loading Job

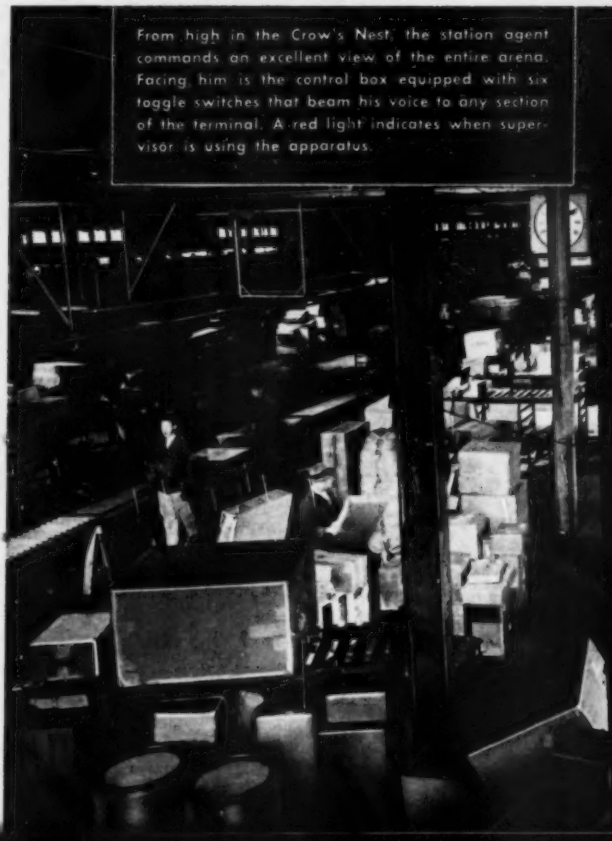
NINETY thousand to 120,000 express packages a day are whisked through the Long Island Express Terminal, New York, and 185 trucks and 75 railroad cars are loaded and unloaded simultaneously, with the aid of an elaborate two-way communications system.

Its "nerve center" is an elevated, glass-enclosed control room called the Crow's Nest, from which a station agent watches the entire plant in operation and talks to freight handlers on the floor by means of 42 loudspeaker horns located throughout the terminal. A "master" microphone also is in a supervisor's office, some 1,000 feet away.

Twenty-five hanging microphones are strategically located along the platforms, which vary in length from a quarter of a mile on one side to 800 feet on the other. These are used to make replies to orders issued over the loudspeakers and are piped into both the Crow's Nest and the supervisor's office.

From his spot high in the Crow's Nest the agent can watch the overhead chain conveyors, driven by 20-hp. motors, that pull trains of double-decked trailers up and down the four platforms spacing the six railroad tracks. Assorters, posted at railroad cars and trucks, remove or put packages on the slow-moving trailers as they go by. Thus, the agent has complete fingertip control over the entire plant, ordering prompt loadings of cars scheduled to move out, advising personnel, and paging workers and receiving replies within a matter of seconds. In emergencies, such as fire or accidents, he can quickly summon help. Despite the high noise level on the floor, reception from the hanging microphones is as clear as normal telephone conversation.

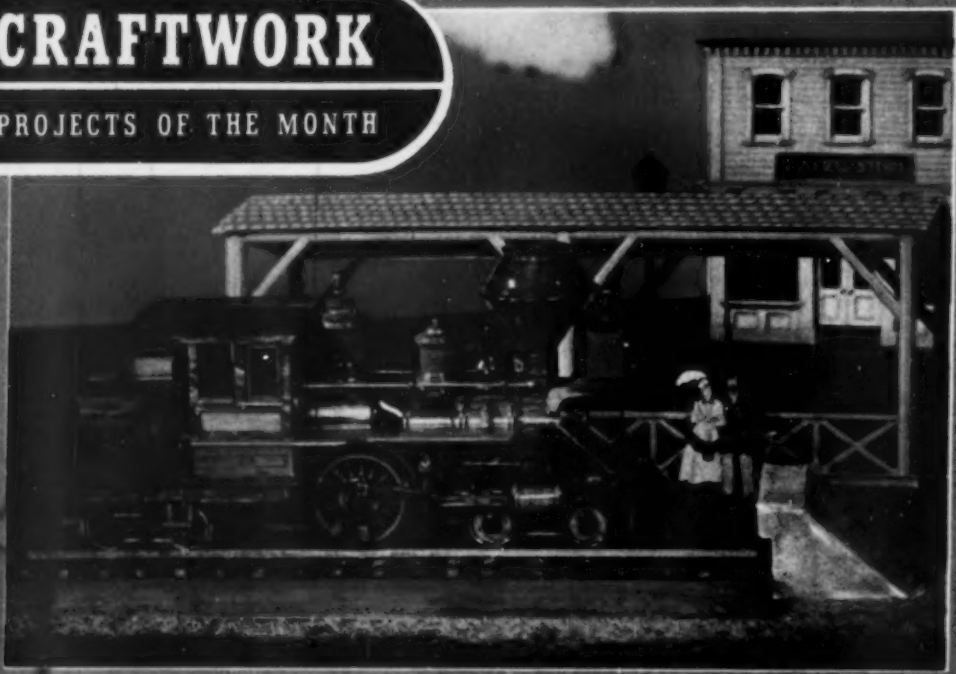
Employees posted at railroad cars and truck lanes take off and put packages on the chain-driven "merry-go-round" conveyor, assorting shipments according to their destinations. Note loudspeakers in upper left and right through which agent in Crow's Nest (semicircle) talks to men on the floor.



From high in the Crow's Nest, the station agent commands an excellent view of the entire arena. Facing him is the control box equipped with six toggle switches that beam his voice to any section of the terminal. A red light indicates when supervisor is using the apparatus.

CRAFTWORK

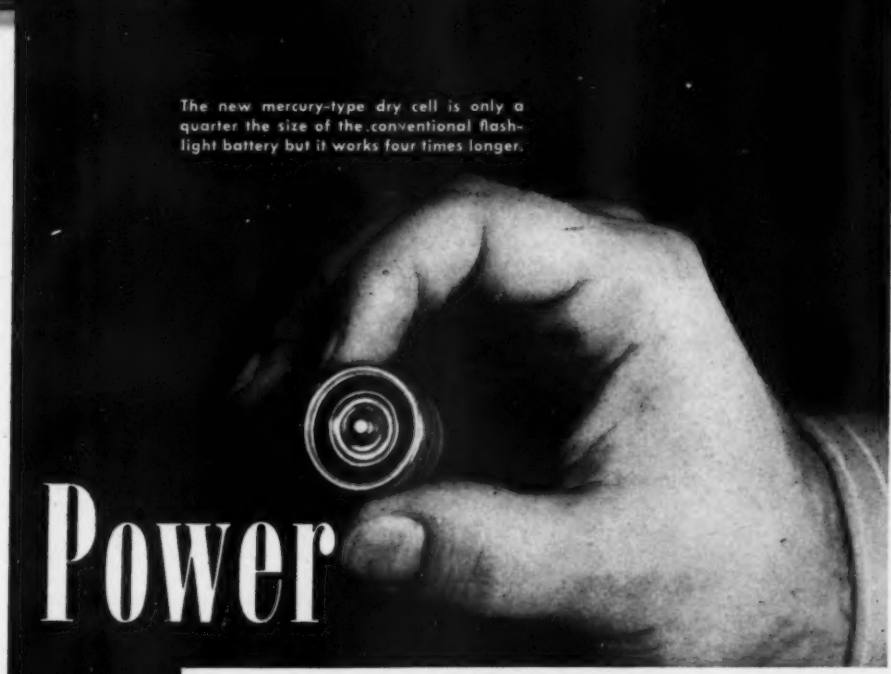
PROJECTS OF THE MONTH



The engine that came round the Horn. Built in 1863, this old diamond stacker, the C. P. Huntington, was sent to California the long way. She was engine No. 1 on the Southern Pacific for many years. The wooden model above is a showpiece any modelmaker will be justly proud of. Plans start on page 150.

With only a motor scooter in which to take his wife and two children out riding, Daniel Wise, Jr., had a problem. The solution is shown at the left—a side car for small fry made from a surplus fuel tank. See page 144.

Three wings are mounted radially on this strange little model plane. It was built by Roy L. Clough, Jr., who gives details on page 171. The vertical wing, fitted with a single aileron, affords lateral stability despite the inverted dihedral.



The new mercury-type dry cell is only a quarter the size of the conventional flashlight battery but it works four times longer.

Power comes in SMALLER PACKAGES

War-born midget batteries benefit industry and the individual.

By GABRIEL ZAKIN

PREPARING the way for smaller, lighter and better portable radios, hearing aids and other devices, specialists in battery design are successfully packing their electrical punches in less and less cubic space.

A dry cell about the size of a checker is the first radical achievement in 50 years of man's quest for packaged, portable electric power. The new mercury-type cell has the same electrical capacity as its older and much bigger brother, the conventional flashlight cell. Furthermore, it works at full strength four to six times longer without rest periods and has a longer life on the shelf.

Small, more rugged batteries with greater endurance are a boon, for instance, to the aircraft industry and to electronics, where every ounce of weight is critical. To the individual they will mean conveniences such as calling home and office at will by means of a pocket-size radio receiver-transmitter, or private listening to favorite radio programs anywhere, with a miniature earphone.

Born of necessity during World War II, the new batteries are made possible by the ingenuity of American engineers, who in four years covered as much ground as the scientists who followed Alessandro Volta's original wet battery of 1798 did in 90 years. It was 1888 before Dr. Carl Gassner produced the first dry cell. Refinements improving quality, uniformity and dependability have not changed the conventional Gassner carbon-and-zinc cell essentially until now.

This standard cell consists basically of a sealed zinc container, which is also the negative electrode; a centered carbon rod, which forms the positive electrode, and a mix of porous material in which the electrolyte fluid is absorbed. This mix, plus the sealing of the container, makes the battery dry. Cur-

rent is produced by the conventional battery as the electrolyte chemicals act on the zinc, which is gradually eaten away and dissolved. This action releases hydrogen atoms. The electric current and the hydrogen atoms flow to the positive carbon electrode. Hydrogen atoms coat the carbon, producing polarization, which finally stops production of current. To offset this blocking, a depolarizing mix containing oxygen-bearing manganese dioxide is packed in close to the carbon electrode. As oxygen and hydrogen atoms combine to form water, the cell is depolarized and current production continues.

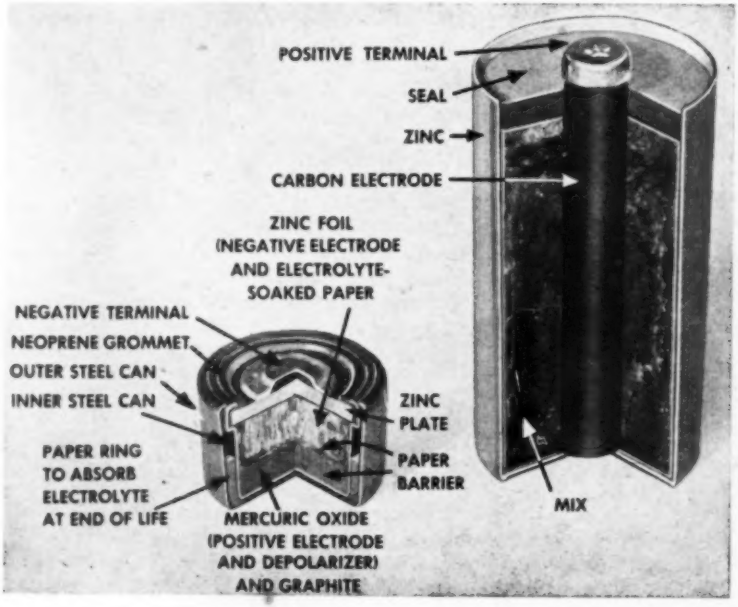
The "inner life" of the cell is thus limited as (1) the zinc is consumed and gets thinner, (2) interaction between zinc and electrolyte creates chemical products that retard and stop action, and (3) oxygen supply from the manganese dioxide becomes depleted so that eventually depolarization cannot occur and the cell can no longer produce current.

The new mercury-type cell incorporates basic changes. Zinc is used as the negative electrode, but it makes its contact through a center terminal insulated from the container. The container is a pair of nickel-plated steel shells, immune to the electrolytic chemicals. The positive electrode, made of mercuric oxide with graphite added to increase conductivity, is also the depolarizing agent. The battery was developed for the P. R. Mallory Co., of Indianapolis, by Samuel Ruben, noted inventor and company consultant.

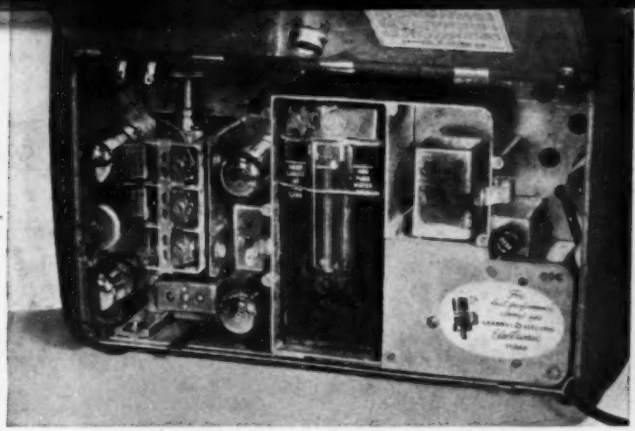
Mallory claims the battery is unaffected by humidity, dry heat, or high altitude; its steel case is noncorrosive, and it has an increased electrical punch at higher-than-room temperatures.

The more expensive ingredients of mercury-type batteries will probably make them somewhat more expensive than standard zinc-carbon batteries of comparable voltage. The manufacturers state, however, that the cost per milliampere-hour of service will be comparable to that of ordinary cells.

The mercury-type cell is not the only wartorn improvement in batteries. Another contender for "more power in less space" honors is the Mini-Max, made by the National Carbon Company. Mini-Max uses conventional zinc and carbon, but differs notably in physical arrangement. Compactness and reduction of nonproductive space were achieved by development of flat cells. These are built up in layered piles and connected to produce desired voltage and power. Oddly, the earliest batteries, made at the end of the 18th century, also consisted of a layered arrangement—a pile of circular disks of copper, cloth pads soaked in acid, and zinc. But it's a far cry from that bulky and uncertain gadget to Mini-Max, so compact and



Cutaway samples show how the tiny mercury-type cell differs from the bulkier flashlight battery. The P. R. Mallory Co. doesn't expect its midget to take the place of the old-fashioned cell entirely, but hopes it will account for 10 to 15 percent of the nation's total dry-cell trade, which averaged $50,000,000 a year before the war.



Fitting snugly inside a portable radio (above), the new Willard storage battery keeps in step with smaller, lighter dry cells despite limitations in design. A plastic container saves weight, and nonspill construction helps conserve electrolytic fluid. At right, the two-volt cell removed from its housing. It operates the radio for 20 hours without recharging.

dependable that special batteries of the type supplied power for the deadly accurate proximity fuse used by the Allies during the war. In the proximity-fuse battery, the electrolytic fluid was carried in a special ampule and released into the cells at the desired moment. This trick may find peacetime adaptation; it produces almost indefinite shelf life.

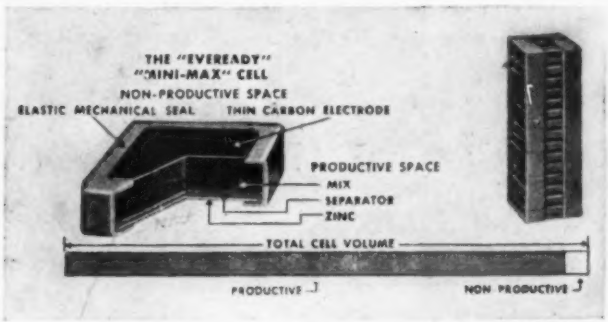
Storage batteries, too, have become more compact, lighter, and easier to carry. New design in this field appears limited because rechargeable batteries seem destined to stay wet, and the danger of spilling the acid electrolytic fluid presents a special problem.

Storage batteries consist essentially of plates in an electrolyte, chemically altered by passage of the charging current through the cell, then producing the useful discharge current as the plate material reverts to its original nature under electrolytic action.

Notable among recent developments is the new cell being produced by the Willard Storage Battery Company, of Cleveland, for General Electric's latest portable radio set. This two-volt battery is encased in a transparent plastic container with special nonspill construction. It is small enough to be held easily in the hand, yet supplies sufficient power to operate the radio for 20 hours. It is recharged by plugging the set into standard house current, the radio meanwhile playing at desired volume. The entire outfit weighs only 20 pounds.

Another smaller-but-peppier product is the new Exide battery developed and produced by the Electric Storage Battery Company, of Philadelphia, for Lockheed's jet P-80. The 12-volt Exide is the size of two conventional six-volt storage batteries, but weighs 10 percent less and provides the power of three standard batteries.

These new batteries are probably only the first in a long series. The good old doorbell-ringing dry cell is still around and useful, but is beginning to look a little overweight next to its modern cousins.



Using conventional chemicals, the Mini-Max attains compactness by physical arrangement. Flat cells keep nonproductive space to a minimum, and layer principle—an old idea—allows construction of small, powerful batteries.

WAX CASTS JET TURBINE BLADES

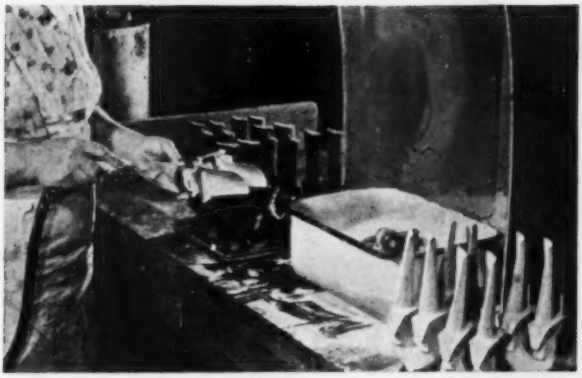
A BIG problem in the manufacture of jet turbines is the mass production of blades to stand the terrific temperatures (up to 1,500 degrees F.) of a jet engine. Metals that can take the punishment are too tough to machine, too hard and brittle to forge. Ordinary casting cannot meet the exacting tolerances required. The answer to the problem, found under the pressure of war, was a process of high-precision casting from wax patterns.

Long used by the Austenal Laboratories, of New York City, for manufacturing metal dentures and surgical appliances, the original process was far too slow. The accompanying pictures show how the technique has been streamlined and how Austenal is using its casting know-how in the production of today's turbine blades.

A wax pattern, shown above being lifted from its steel mold, is made by injecting molten wax of a special formula into the mold under pressure, which forces the wax into every cranny. The pressure is maintained until the wax sets. Dry ice, a chunk of which is on the clamp in the background, helps keep the mold cool and hastens the hardening process.

PSM Picture Story by HUBERT LUCKETT

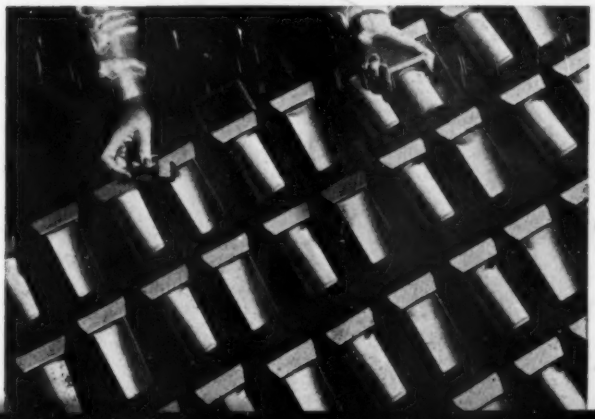
The pattern is checked (below) with a special gauge to insure accuracy. Castings made from these patterns are held to a tolerance of plus or minus .003 inch. In the right background are patterns that have been checked and fastened in pairs to preformed supports, which provide an exit for the wax when the final mold is heated.



To provide a smooth finish on the castings, the pattern is dipped in a water suspension of finely ground silica powder, which forms a coating on the inside of the final mold when the wax is melted. The operator at left is partially drying the dipped pattern with an air hose before sprinkling it with a layer of coarser silica powder. At the right of the pan are coated patterns ready for the ceramic mold from which metal castings are made. The thin rods between the two halves of the pattern in the operator's hand are test wires that permit a check on each batch of metal to make sure it is up to standard.

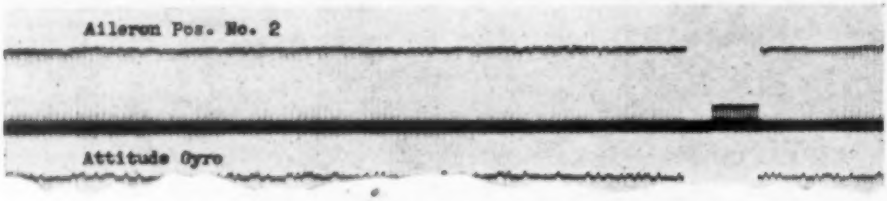
A coated pattern, pouring end down, is mounted on a steel base (right) and a metal flask with a long paper liner is put over it to form the final mold. The container is filled with a thick silica paste, jolted on a vibrator and allowed to settle, after which any surplus paste is cut off flush with the top of the flask.

Caster (above) places the mold on an electric furnace after it has been baked red-hot in an oven to harden the silica and melt out the wax. The mold is put on the furnace upside down and the furnace is inverted, allowing a molten alloy, under pressure, to fill the mold. Only enough metal for one mold is melted at a time; melting time is about 12 minutes, and pouring temperatures range from 2,800 to 3,100 degrees F., depending upon the casting's size and shape. The mold is allowed to cool slowly and then is broken away from the metal core. Abrasive cut-off wheels are used for finishing the casting.



Besides undergoing X-ray tests, each casting is examined for flaws with ultraviolet light before receiving the stamp of approval. The casting is dipped in oil and dusted with fluorescent powder. Any minute crack in the casting retains oil, and powder adheres to it. Under an ultraviolet lamp the powder fluoresces, revealing the flaw.

Tracking a Plane on Tape



Section of telemeter tape shows part of a plane's flight record.

AN AIRPLANE undergoing flight tests, once a mystery to its engineers until after it landed, can now report its own performance in a detailed story flashed instantaneously to the ground crew and recorded on a tape for study. A telemeter, the device that makes such reports possible, automatically notes every movement of the plane, its speed, altitude and attitude, and the actions of various parts.

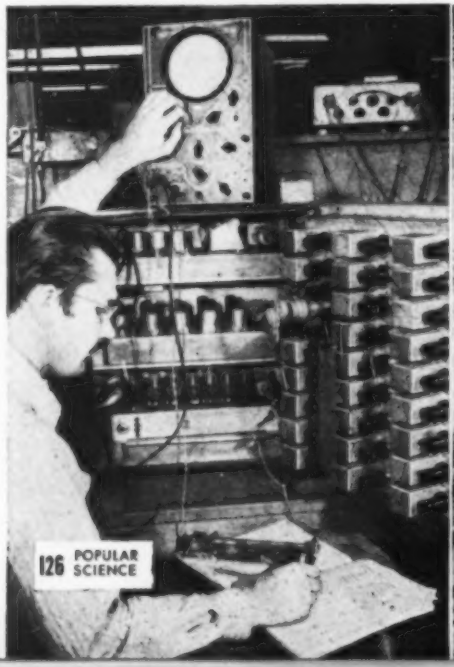
Designed by Boeing Aircraft Company engineers, the telemeter combines automatic radio transmission and oscillographic recording. Thirty-nine special instruments in the plane translate its movements into electrical impulses, which are transmitted to the telemetering truck on the ground and transformed by oscillographs into graphs or curves on photographic paper tape.

The instruments require frequency separation and time separation to identify their readings. This means using a scanner to read them one at a time.

In transmission, five instruments on five different frequencies are scanned at a time; their impulses, jumbled together, are relayed to the ground to be unscrambled and recorded on the tape. Another five are then scanned, transmitted, and recorded, and so on until 25 have been read. This does not take long, since each instrument is read 20 times a second. The other 14 instruments use only frequency separation and are recorded continuously.

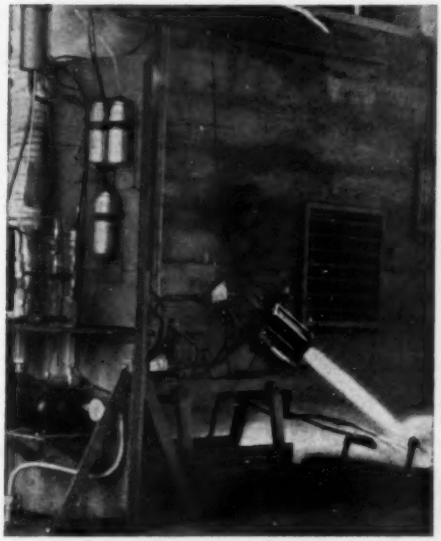
When developed, the tape gives engineers a complete picture of the flight, with 39 versions of just what happened in the plane at any particular moment.

Boeing radio engineer, inside the truck, checks on oscillograph recordings from an airplane in flight.



The telemeter truck permits ground crews to go on location to chart the inside story of flight tests.

Tests Rocket Fuel. Looking like a theatrical spotlight, this tiny engine at California Institute of Technology is testing liquid oxygen and alcohol, a fuel the Germans used in their V-2s. It develops 250 pounds of thrust as flame flares from its ⅝-inch nozzle against a water-cooled steel plate.



Mechanical Striper. Speed, ease and economy are combined in this device for painting safety stripes for traffic lanes, steps, and platforms. Controlled by a finger trigger, paint flows from hollow handle and is applied with a carpet-covered roller. Capacity is three pints.

Streamlined Motorcycle. A 6½-hp. engine drives this two-wheeler 40 miles on a gallon of gas, gives it a top speed of over 40 m.p.h. Made by Salsbury Motors, Pomona, Calif., it features an automatic clutch and transmission.

Dictating to a Wire. Hooked to any 115-volt AC circuit, the compact Peirce wire recorder, distributed by Bell & Howell, is good for 66 minutes of continuous recording. An amplifier unit permits use of the wire record for public-address work.

TOOLS for WORKMEN WHO CANNOT SEE

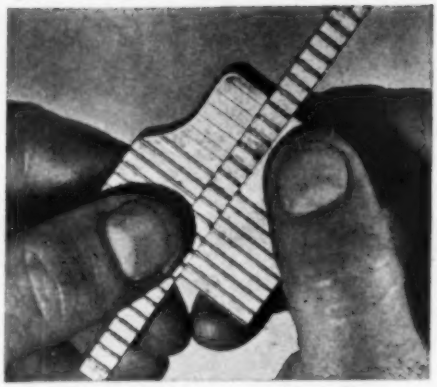
New aids for blind craftsmen put fingers and ears to work even at technical jobs.

By GOLD V. SANDERS

A BLIND man now can find out what's wrong with your ailing radio just about as quickly as a man with perfect sight, by using a device invented by an ingenious blind physicist. Dr. Clifford Witcher, of New York City, sightless since he was three weeks old, has perfected a Braille analyzer with which a blind radio serviceman employs his senses of touch and hearing to measure electrical quantities.

This is but one of several newly invented devices that promise a brighter future for ambitious, mechanically minded blind persons. Dr. Witcher has also made a micrometer with which they can readily measure a thousandth of an inch, and a vernier depth gauge that gives their sensitive fingers quick measurements in sixty-fourths of an inch.

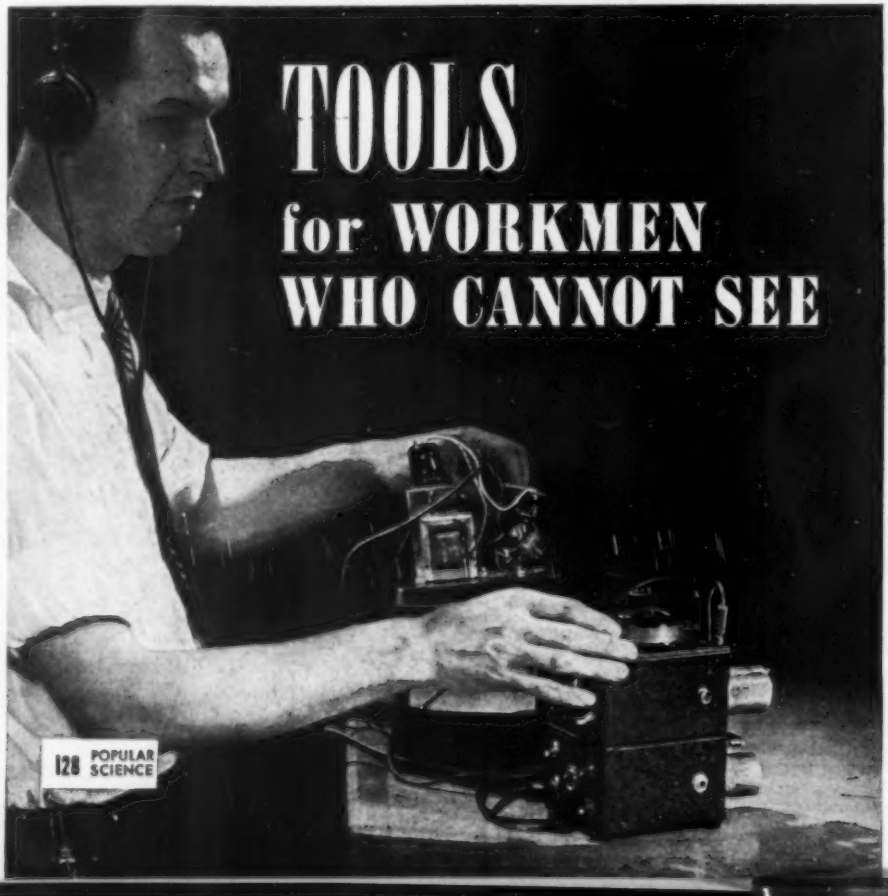
These and other new aids for the blind pictured on these pages are being prepared



Raised ridges on the division lines of the vernier depth gauge (above) make it easy for the sensitive fingers of a sightless person to take measurements with it, accurate to 1/64 of an inch.

PSM Staff Photos

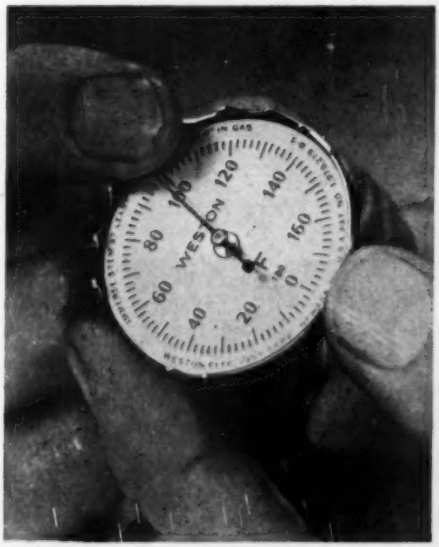
Dr. Clifford Witcher, blind New York physicist, demonstrates for Popular Science Monthly his Braille analyzer (below, in foreground), which measures voltage, amperage or resistance to disclose what is wrong with a radio circuit.



Old phonograph records provide slide rules large enough for Braille markings. The symbols, around the rim on the under side of the disk, correspond with notches on the top side, permitting speedy calculations. Raised marks also identify the two pointers.

An ordinary compass can be converted for touch reading with the addition of a button to hold the needle in place while the user's forefinger determines its position. The north-pointing end of the needle has wire around it for quick identification.

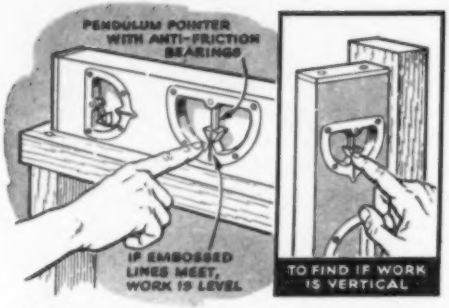
The photographic or laboratory thermometer below has carefully spaced notches around the edge of its dial that allow the position of the needle to be determined by touch. It is one of the developments of the American Foundation for the Blind.



A disk on the barrel and a spirally marked post at the side of a standard micrometer adapt it for use by the blind. Each division on the disk represents 1/1,000 of an inch, and the ridges on the side post keep track of the revolutions made by the barrel.

for manufacture by the Technical Research Council of the American Foundation for the Blind, in New York. This council is a clearing house for new ideas; sorting out the feasible ones, it builds models, simplifies devices, and arranges for their manufacture at cost for those who can use them.

Most devices to help the blind are invented by the blind themselves—probably because people with normal sight generally do not know what is needed. Dr. Witcher's inventions all grew out of his own necessity.



Two free-swinging pointers, one for horizontal and one for vertical indications, replace the usual bubbles in a carpenter's level designed to permit easy and accurate readings by sightless craftsmen.

An electronics expert with a Ph.D. from Columbia University, he did important work on radar at the Bell Telephone Laboratories during the war.

In his research work, Dr. Witcher had daily need of a precision gauge, so he adapted a standard micrometer for touch reading by putting a disk with raised lines on the turning part. At first he took readings by counting the turns of this disk, but that was too slow; so he devised another part with raised lines that serve to count the turns.

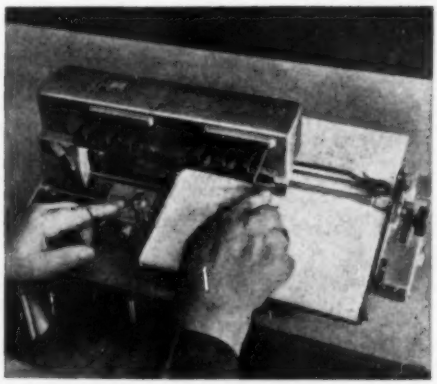
Dr. Witcher's Braille analyzer, in its present compact form, is the outgrowth of at least five years of intensive inventive effort. It consists of a small, easily carried box and a pair of earphones. The operator adjusts a potentiometer until the analyzer's audible signal fades out, then calculates on a Braille scale the value of the electrical quantity involved.

Blind persons now wait hopefully for good news from the Haskins Research Laboratories in New York, where a staff of top-notch scientists is attempting to develop new guidance and reading devices for them, based on the latest knowledge of light and sound phenomena. These scientists hope to construct instruments that will guide the blind somewhat as radar guides an airplane pilot through clouds and darkness. This ambitious program is sponsored and financed by the Office of the U. S. Surgeon General, and continues work done during the war by the Office of Scientific Research and Development.

Among the aids being worked upon intensively here is the "optical cane," partly developed by the Army Signal Corps. A photoelectric cell is the heart of this guiding device, which is carried like a briefcase and looks like a new-type, elongated camera. Reflected light activates the cell, producing a signal audible in earphones. It is far from being perfected, according to Dr. Frank C. Cooper, head of the Haskins research staff. In fact, none of the devices under study has been perfected, but the staff has found clues of great promise and is pressing its research.

With such a program being pushed by the government, and with the development work being done by the Technical Research Council of the Foundation, the outlook for the blind is more hopeful than it has ever been.

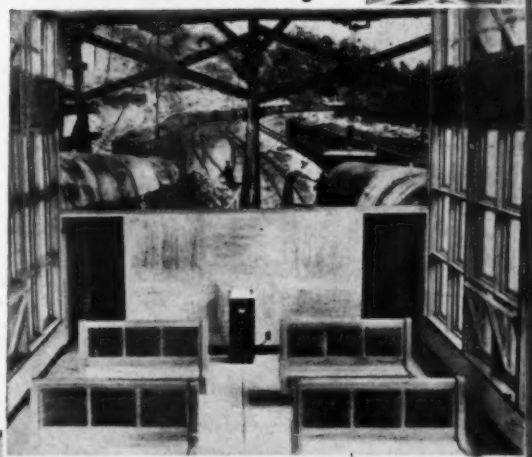
Another special thermometer for the blind. It uses a system of raised dots to indicate the position of the pointer. Double dots at −30, 0, 30, 70 and 100 degrees and single dots at intermediate figures facilitate readings by trained fingers.



This eight-pound, six-key Braille typewriter was designed by J. Robert Atkinson, blind general manager of the Los Angeles branch of the Braille Institute of America, where the machine is now in regular production after several years of development.

Heated Floor and Ceiling Will Keep Station Cozy

THE nation's first railroad station with a radiant heating system has been built at Prince, W. Va., by the Chesapeake & Ohio Railroad. Hot-water pipes, which warm the surrounding surfaces rather than the air, are built into the ceiling (above) and floor (below). The system will provide comfort at lower temperatures than usual, permit use of all floor space, and reduce drafts. The building (exterior view at right, above) is designed as a model for future stations, and includes such features as the window-like photomural at the right.



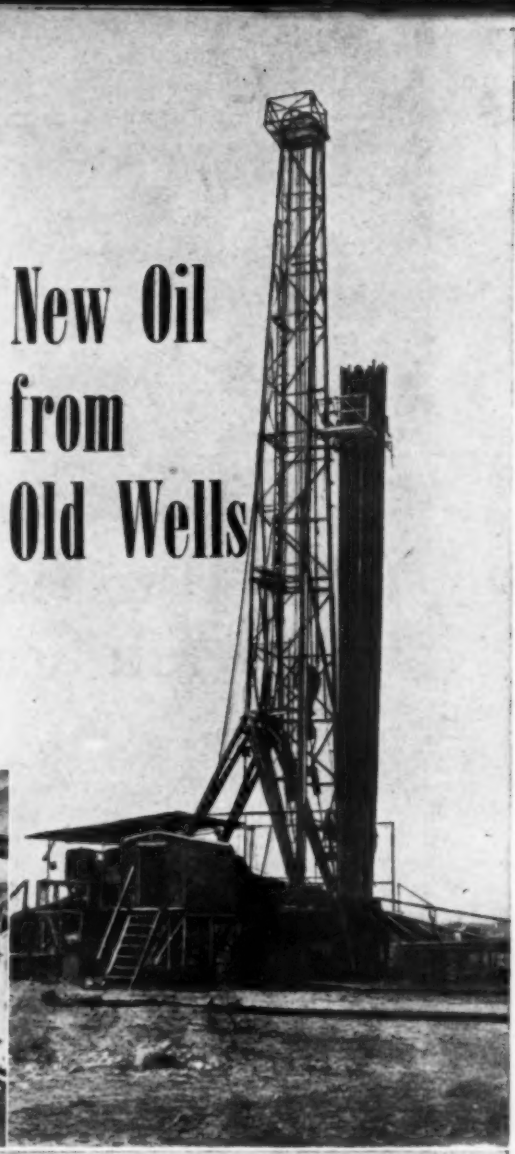
New Oil from Old Wells

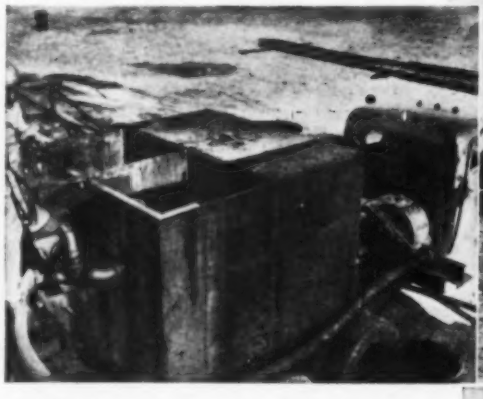
TEXAS oil wells are being killed off deliberately, and then brought back to life, to increase their productivity. A liquid plastic, forced into their veins, is used as the rejuvenating agent. Wells that in times past had to be abandoned are now being forced to yield $1,000 worth of oil a month.

The chain of production-death-revival is made necessary because of the seepage of natural gas into the strata holding petroleum. The gas, under pressure beneath the immediate crust of the earth, grows in volume as a well gets older. Presently, too much gas is intruding itself into the well for the amount of oil pumped up.

Here a state law steps in. When the ratio of gas to oil becomes too great, pumping either must stop or be so reduced that it is not profitable to operate the well. That was the problem posed for two men, Fred R. Holland, of the Oilwell Chemical Service Co., Ft. Worth, and Lawrence Debing, of the Monsanto Chemical Co., St. Louis. In plastics they found their answer.

The job was to seal off the gas. Each well has a "flow string," or tube, through

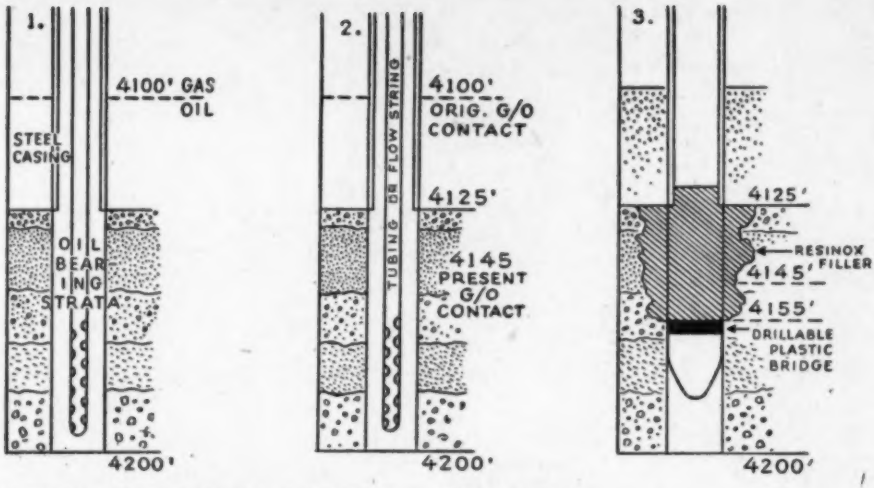




Upper right: This rig, 92 feet high, is hauling out the "flow string" of an ailing New Mexican oil well and racking the long sections of pipe before applying the new plastic cure that will make the well a lively producer again. The rig is of a special type used to rejuvenate old oil wells and is generally owned by contractors.

Right: Running-in the plastic bridge on the end of a steel cable. A measuremeter and weight indicator tell the operator when plug has hit the right level.

Above: The motor of a truck alongside the rig supplies the power to pressure-pump the resinlike liquid into the well. Then water is pumped in as a chaser to force the viscous substance down.

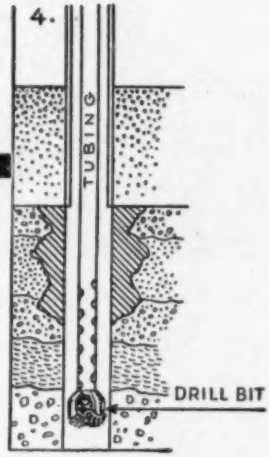


1. With gas-oil contact point at 4,100 feet, a well's production of 50 barrels of oil and 37,500 cu. ft. of gas a day is economical.

2. At 4,125 feet production drops to five barrels a day and 100,000 cu. ft. of gas. Well is a liability and producing at illegal ratio.

3. Flow string is removed and well is "corked" at 4,155-foot level. Plastic is pressured into the porous rock, hardens in eight hours.

4. With unwanted gas sealed off, drill bit on flow string bites through plastic and plug and 50-barrel-a-day production is resumed.



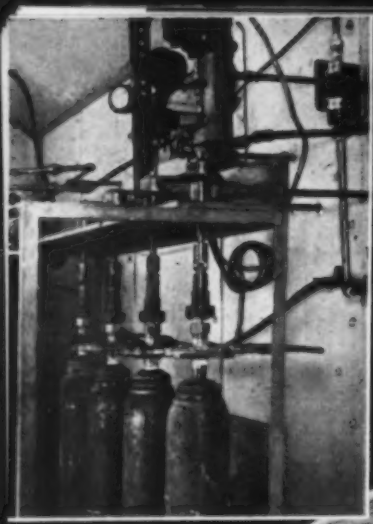
which oil is pumped. They pulled out this tube. The next step was to lower a "bridge," or plug, interposing a cork between oil-bearing and gas-bearing strata. Then they put the flow string back into the well, and through the perforations in its base pressure-pumped a sticky resin sealer into all the crevices that were permitting gas to seep into the well.

Drillers had only to pierce the layer of plastic after it had hardened and punch on through the plug below it. The bit emerged into oil-bearing sands, and the well once again was a profitable producer.

Liquid plastic can also be used to exclude another unwanted oil-well intruder—water. To seal off water entering the midsection of a well, a plug is inserted in the same way one is used to eliminate gas. But for "bottom-hole" plugging, an older method is used. The bottom of the well is cleaned out with a sand pump, or with a drill if necessary, and enough plastic is put into the well to fill it to a desired depth. After this plastic hardens, enough more is added to make up for the amount that seeped into the rock crevices. The well is then ready for production again. Despite its usefulness against water, however, the plastic's most effective field is in maintaining control of gas-oil ratios.

Other gas sealers have been used in the past, but the plastic has proved to be easier and less expensive to deliver to points at considerable depth. It has stopped the flow of gas as far down as 11,500 feet. In western Texas alone, it is estimated there are between 4,000 and 5,000 wells that have become either marginal or nonproductive. So far only a small percentage has been given the plastic treatment.

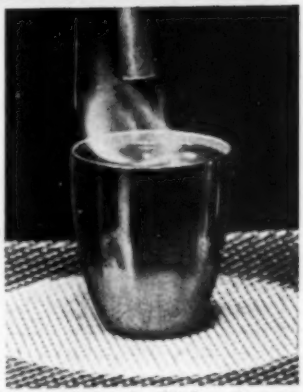
The entire job of rejuvenating a well can be done by a seven-man crew in about 36 hours. In some instances wells have been taken off the pump because the oil has returned to conditions of natural flow.



Taming a Chemical Terror

Elemental fluorine is packed in steel cylinders (upper left) located behind a half-inch steel barrier, as a technologist checks the loading through a two-inch bulletproof window (upper right). Control valves that extend through the steel wall are within easy reach.

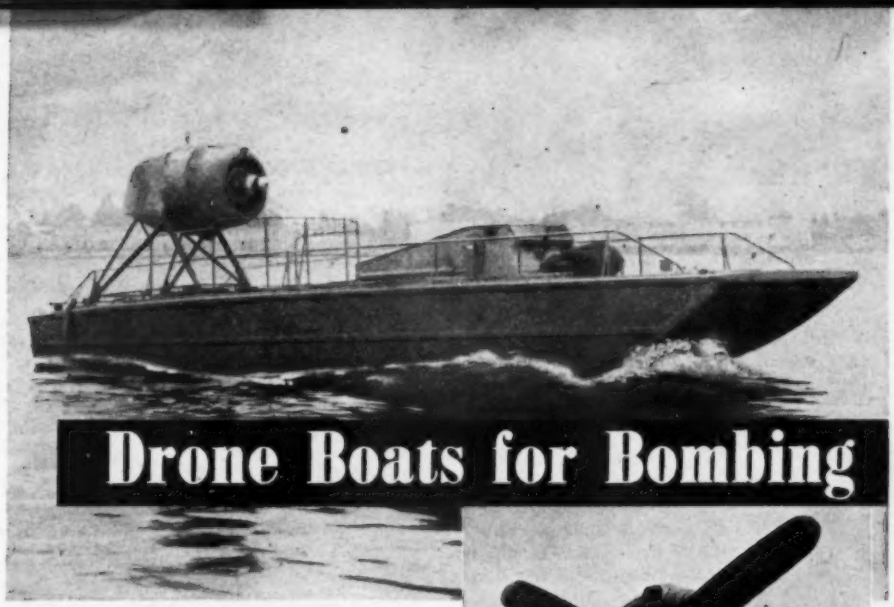
Fluorine is a nearly colorless gas about 30 percent heavier than air, has an intense odor, and is highly irritating. It reacts vigorously with most metals, and will even burn glass and water. Above, a piece of wood bursts into flame when simply placed in a jet of pure fluorine gas; at right, the gas makes water burn.



FLUORINE, a chemical bad actor that was discovered 133 years ago but defied isolation for 73 years, at last is about to lead a more useful life. Most active chemically of all the elements, this glass-burning gas is being marketed on a limited commercial basis by the Pennsylvania Salt Mfg. Co., of Philadelphia. It is intended for experimental use by manufacturers and researchers.

Scientists predict a whole new field of chemistry in the development of fluorine compounds. They look for products that will include a more stable lubricating oil; a nonburning, nonpoisonous liquid to replace mercury in the mercury-vapor boiler; a gas, requiring elemental fluorine to make, that is a nearly perfect insulator for high voltages; and a wonder insecticide. Other beneficial work the reformed delinquent, flourine, may do is awaiting it in fire extinguishers, resins, plastics, anesthetics, and weed killers.

The rapidity with which fluorine combines with almost all other elements was the greatest stumbling block to its isolation and research on its use. On the other hand, the stability of most of its known compounds is perhaps their chief value.



Drone Boats for Bombing

A 950-hp. Wright Cyclone engine taken from an old SBD plane powers this speedy target for Navy student bombers. Engine (right) can be removed from double-tripod mounting and replaced in 20 minutes.

ZIGZAGGING, dodging and twisting, crewless bomb boats like the one above are leading embryo Navy pilots a merry chase in practice bombing and torpedo-dropping operations. Powered by obsolete 950-horsepower Wright Cyclone engines from old Navy dive bombers, this new-type, highly maneuverable craft can do 30 knots an hour and has a maximum range of 250 miles.

A radio remote-control unit is used when the 46-foot-long "water bug" is undergoing bombing. Small electric motors, activated through a solenoid system by radio impulses from a mother ship, operate the steering gear and throttle. For nonhazardous operations, a one-man crew can work the controls either manually or by a push-button system in the cockpit.

Instead of being heavily armored with steel plate, which made early Navy bomb boats sluggish and hard to handle because of the weight, this new type is made of 1/4- and 5/16-inch plywood and is a maze of many compartments. Although practice bombs are light, with only enough explosive charge to mark the point of impact, even a 10- or 25-pound bomb dropped from 150 to 1,500 feet hurtles down with enough momentum to plow through the average boat. Thus, a hole in any part of the boat will flood only a small compartment and the damage can be easily and cheaply patched.

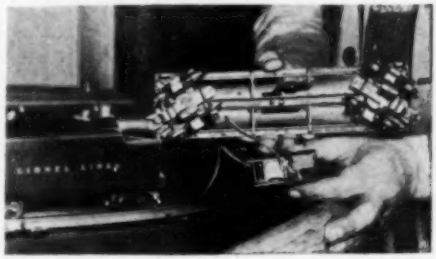
The hull is broad and shallow and of an inverted double-V design, each V unit acting like sled runners as a pivot on sharp turns. Fully loaded, the maximum draft is less than one foot, allowing the boat to navigate shoal waters.

Two automatic safety switches protect the engine against serious damage and the boat against fire. If the engine is hit by a bomb, a switch controlled by the drop in oil pressure cuts off the fuel supply and grounds the electrical system. Should the engine catch fire, another switch on the cowling, its contacts held open by two nylon threads, will close when the fire burns through them, thus flooding the gasoline tanks below decks with carbon dioxide.

AIDS TO MODERN LIVING

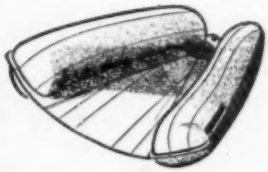
SHAVER HOLDER. With a self-winding reel for the cord and an automatic switch, this holder for a Schick electric shaver is designed for mounting near a bathroom mirror. Pick up the razor and the current turns on; put it back and it shuts itself off; touch a button and the dangling cord is automatically reeled in.

ELECTRONIC CONTROL of model electric trains has been developed by the Lionel Corporation, of New York. Each car is equipped with a receiver tuned to one of ten radio frequencies generated by a one-tube transmitter and superimposed on the regular power leads. Thus, an individual car can be made to perform a particular operation, such as dumping coal.



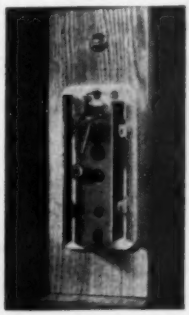
HEAT ON BOTH SIDES of an article being pressed is provided by this new ironing board, in which heat from the iron is reflected by the ⅛″ aluminum-alloy surface. The lightweight board is backed with insulation, folds to fit into a traveling bag or a dresser drawer, and can be used flat on a desk or table or on the backs of two chairs. It is manufactured by the Ruhl Development Co., of Toledo, Ohio.

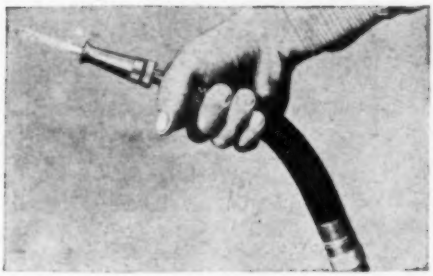
FUN AFLOAT. Lazy floating, the thrills of riding the surf, or brisk "float-planing" behind a power boat are all possible with a canvas device manufactured by Chandler Industries, Inc., of Buffalo, N. Y. An eyelet in front permits towing, and hand grips on the sides and a pull-up strap on the top assist the swimmer in getting aboard. Lung power provides sufficient air to inflate its two plastic-film envelopes. Deflated, the float folds into a package 10″ square weighing less than 2 lb.



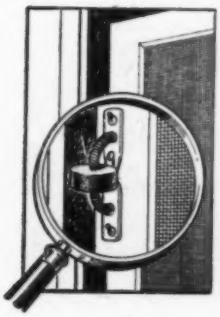
Triangular in shape, the float is large enough to support an adult. Two plastic-film tubes, inflated by mouth as you would a balloon, keep it buoyant for a long time.

DOOR-KNOCKER CHIMES manufactured by Auth Electrical Specialty Co., of New York, are mechanical in operation and require no wiring. Housed in a 3″ by 8¾″ ivory-enameled box inside the door, the mechanism strikes one note when the knocker outside is lifted and a second when it is released. The chimes are easily installed.





AUTOMATIC WATER CONTROL is possible simply by flexing this new garden-hose nozzle. A valve built into a short length of hose having a standard coupling remains closed while the hose is straight. If the hose is flexed, the valve opens to allow flow in proportion to the degree of bend. The nozzle is made by B. F. Goodrich Company, Akron.



NO-BANG CLOSING for screen and storm doors is aided with this device on the door. A spring and rubber wheel take the shock of closing by rolling the door shut silently. The gadget is made by the Screen Patch Company, of Philadelphia.

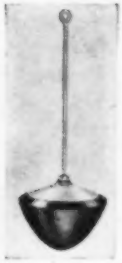
WINDOW WASHING IS EASY with a new double-hung sash that pulls down and inward, as shown above, for access to the outside of the panes. The sash, a product of the Mauro Safety Window Co., Inc., of Brooklyn, N. Y., can be locked at any angle.

FOLDING SAWHORSES are one of the newer products for both the handy man and the working carpenter. Manufactured by the Unique Tool Products Company, of Chicago, the horses are sturdy and of the customary size, but each folds to 8″ by 8″ by 42″ for storage or carrying in a car trunk. Each horse contains a tool tray.

TWO NEW RAKES will make it a pleasure this fall to keep lawns free of leaves. The Smoothie, shown at the left, has a one-piece aluminum head with wide tines that won't gouge. It weighs only 1 lb. The Joell Manufacturing Co., Seattle, makes it.

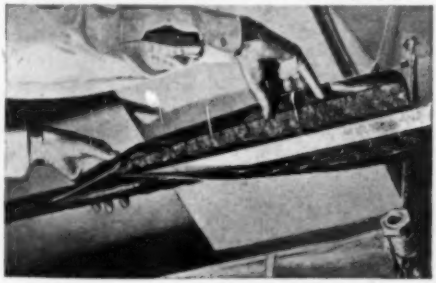
The Pelican Pick-up Rake (right), a product of Ferris Factories, Inc., of York, Pa., has double steel tines, the rear set hinged to provide jaws for picking up leaves.

CLOTHES ON A TRAPEZE BAR are within easy reach of a child. The bar above, manufactured by Children's Utilities, of Detroit, is equipped with long hooks that are hung over the ordinary closet rod. It thus becomes a low, extra bar for the use of a youngster in his own clothes closet. No nails are needed for installation, and plenty of room is left on the upper bar for hanging additional clothing that is not required by the child for daily wear.



A NEOPRENE FACE on this flush-tank ball is molded to fit all standard tank-valve seats. It also has a plastic top designed to prevent the ball from collapsing under steady use. An expandable-plug connection to the lifting rod eliminates danger of stripping threads. Rayco Company, of New Haven, makes it.

MOISTUREPROOF JACKETING has been developed by Mystik Adhesive Products, of Chicago, to insulate and to prevent condensation on home water pipes. The jacketing, which is shown in the photograph below, comes in 6′ lengths in one size for pipe up to 1″. It is applied by sticking its own adhesive edges together. Two or more lengths may be spliced for use on large pipes.



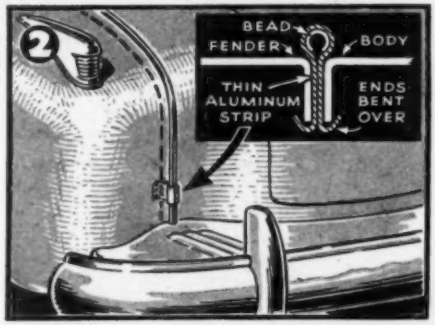
AUTO HINTS

RUB ON WAX AS USUAL...

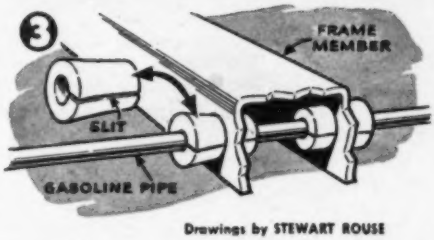
DUST CORN STARCH ON WAX...POLISH

1. CORNSTARCH PUTS A SHINE on a car with a minimum of elbow grease. Try sprinkling a little on after you have applied the polishing wax and before you do the rubbing. You'll find that the task of producing a durable luster is considerably simplified. The cornstarch comes off with the rag, which should be shaken out often during the rubbing.—R. H. E.

2. LOOSE FENDER BEADING may be anchored in place with narrow strips of aluminum bent over the beading and under the fender and body, as shown in the drawing. This is a good way of retaining beading that threatens to come off because of rotted fabric or damage to the fender or body.—W. E. L.

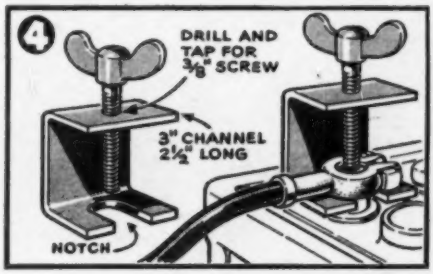


3. GAS-LINE RATTLES sometimes occur when the pipe joggles against frame members through which it passes. An easy remedy is to use rubber corks, drilled, split, and inserted as shown. They will not only stop rattles but will also prevent vibration and possible failure of the line.—A. H. W.

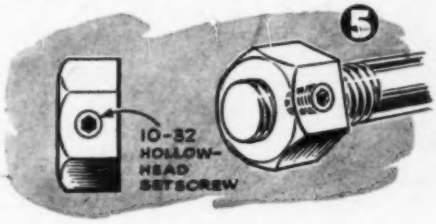


Drawings by STEWART ROUSE

4. TIGHT CABLE LUGS can be pulled off without straining battery posts by means of this simple puller. The notch in the length of channel stock goes around the post and under the terminal. A thumbscrew or a bolt and wrench will serve.—A. H. W.



5. THEFT OF ACCESSORIES can be made difficult with this homemade lock nut. Few thieves will have a wrench for the hollow-head setscrew that locks the nut. The setscrew should be flush and should engage a dimple drilled in the stud.—T. K.



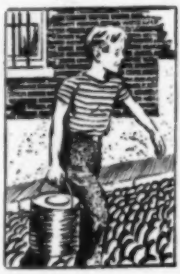
GUS Catches a Gas Thief

By MARTIN BUNN

JOE CLARK stuck his head through the door leading from the office-showroom to the Model Garage shop and called to his partner: "Hey, Gus! Lady to see you."

Gus Wilson was busy on a valve-grinding job he wanted to finish so he could go bass fishing. "What does she want?" he demanded ungallantly.

The remainder of Joe's anatomy followed his head into the shop, and he shut the door.



"She says she wants to talk to *Mister* Wilson—and no other," he reported, a grin splitting his thin face. "I don't know what she wants, *Mister* Wilson, but I do know that she's well worth talking to."

Gus scowled. "Every time I get started on a job, I get interrupted," he grouched. "First it's Stan Hicks wanting to be shown something. Then it's the phone. Now it's you wanting me to stop and see some dame who's probably collecting for some charity." He produced a half dollar from his coverall and spun it toward Joe. "Give her that, and leave me alone."

Joe, still grinning, plucked the coin neatly out of the air and dropped it into his pocket. "She wants to talk to *Mister* Wilson," he repeated. "I'll tell her you'll be in."

He went back into the office, and Gus, still grumbling, followed him. When he saw the girl sitting in Joe's desk chair, he lost no time in wiping the scowl off his face and replacing it with his best smile.

She was very businesslike in her dark-blue suit and little hat to match, but she had what nylons need to make them look their best, and the gray eyes that smiled back at Gus made him remember things that had nothing whatever to do with automobile engines or the garage business.

"This is our Mr. Wilson, miss," Joe said unctuously. Then, unable to get back to his ledgers while she was sitting at his desk, he went to the showcase and began fussing with the gadgets he displays in it.

"I'm Lucille Andrews, Mr. Wilson—I work for the Child Welfare League," the girl told Gus. "Mr. Corcoran, the state trooper, suggested that you might help me with a problem I have. He says you're fair-minded."

Gus reddened, conscious that Joe was listening. "Well, I—I try to be," he sputtered. "But what's this problem?"

"Mr. Corcoran tells me that you know Mr. Barnstable—Silas Barnstable—who lives in the Hillcrest Apartments."

"Yes, I know the old—er—the old gentleman," Gus agreed.

Lucille's cheek dimpled. Then she laughed. "I guess what you were going to say would have been a better description," she said. "Mr. Barnstable *is* an old grouch. I know him quite well—my sister and I have the apartment above his. Do you happen to know a boy named Tommy Black?"

Gus shook his head.

"Well," Lucille went on, "I'm afraid that Tommy isn't a model boy, but considering the poor chance he's had in life, I don't think he's so bad. He isn't 14 yet, and he's been in minor trouble a couple of times. That's making it bad for him now that Mr. Barnstable wants him arrested for stealing gasoline out of his car. You know Mr. Barnstable. He considers paying garage rent a wicked waste, so he leaves his car all night on that steep cobblestone side street beside the Hillcrest."

Gus nodded. "I know the place," he said. "It's ideal for car thieves—dark, and usually no one around. Of course, old Silas wouldn't spend a couple of dollars for a fuel-tank lock. But why does he blame Tommy?"

"I'm afraid he has something pretty definite," Lucille admitted unwillingly. "The first time he missed gasoline was a week ago. He had his tank filled Friday night, and Saturday morning there was so little gasoline in it he got stuck 15 miles out in the country. When the service-station man couldn't find a leak, Mr. Barnstable remembered that he had looked out his window about 11 o'clock Friday night and seen Tommy coming up the hill lugging a big, heavy can. He was sure it was Tommy because he saw him under the street light at the corner."

Gus was silent. He tamped his pipe.

"Mr. Barnstable wanted Tommy arrested and called Mr. Corcoran, but he argued him into waiting for stronger evidence," Lucille

explained. "So they began watching the car at night. But I guess the thief waited until they left, because it wasn't until last night that they saw anything suspicious, though gas was missing again each morning."

"What happened last night?" Gus asked.

"I was watching from my window last night about 10 o'clock and saw Tommy going down the hill carrying a big can. Just then Mr. Corcoran turned in from the main street and caught him in his headlight. He came down the hill fast, yelling at Tommy to stop, but Tommy dropped his can and ran. And then—" Lucille's dimple returned to her cheek—"then the motorcycle hit a bump, ran up the curb, and threw Mr. Corcoran into a rose bush. When I got down, his face was bleeding where the thorns had scratched. And was he mad!"

Gus chuckled, thinking of Jerry Corcoran's wounded face and worse wounded pride.

"This morning," Lucille continued, "I went to see Tommy. He was scared and admitted he had been near the Hillcrest with a big can both nights he had been seen, but he denied he had bothered Mr. Barnstable's car. He wouldn't say what he was doing with the can, but somehow I believed him and persuaded Mr. Corcoran to wait before arresting him. It was then he told me to see you—that you might be able to explain why Mr. Barnstable has been losing gasoline."

Gus scratched an ear reflectively. "Both times Tommy was seen near Silas's car were on Friday nights," he mused. Then he apparently remembered something he had forgotten. "Excuse me a moment," he said. "I have to make a phone call." He dialed a number. "Jack's Sport Shop? Get that live bait yet? . . . He hasn't shown up? . . . O.K. Maybe I'll do better with plugs."

Lucille looked reproachfully at him. "You think Tommy *did* steal the gasoline?" she

"Jes' you remember this—you do my car any damage, and I'll take you to court."

asked, her voice revealing disappointment.

"I'm practically certain he *didn't* steal it!" Gus grinned with reassurance. "But I'll have to get hold of Silas's car to prove it. Do you think you can get his permission? The last time I saw the old skinflint he accused me of cheating him when I had only charged him half what a job was worth."

Lucille's gray eyes sparkled. She smiled dangerously and held up a slim forefinger. "I'll twist Silas right around it," she promised. "Then I'll phone you as soon as I can—I know you want to go fishing."

HALF an hour later the phone rang. "It's all right," Lucille told Gus triumphantly. "He says you can examine his car."

"I'll be right over," Gus said. "How did you get around that old sourball?"

Lucille laughed. "I just told him it was a chance to get his car checked by an expert without charge."

Within 10 minutes Gus was driving the wrecker down the steep street at the Hillcrest and came upon Lucille, Trooper Corcoran, and Barnstable, a wealthy little retired farmer who looks like a bantam rooster.

"I'm a-goin' to watch you, Gus Wilson," Silas cackled. "You ain't a-goin' to save that young scallawag by any shenanigans!"

Gus grinned widely at Jerry's scratched face and walked slowly around the car.

"Can't do anything on this hill," he decided. "I'll tow your bus to my shop, Mr. Barnstable. It won't cost you a cent, and I'll give you enough gas to get you home."

Silas tilted his stiff-brimmed straw hat over his steel-rimmed spectacles.

"Go ahead," he consented. "I don't know what trickery you're up to, but jes' you remember this—you do my car any damage, and I'll take you to court."

Gus winched up the front of the old sedan after its owner got into it. Lucille climbed into the wrecker beside Gus. Trooper Corcoran led the way on his motorcycle.

Back in the Model Garage, Gus maneuvered Barnstable's car into the middle of the shop floor, and then drove the wrecker out. When he came back, he looked at the fuel gauge and saw that the tank was empty.

"How much gas did you have last night?" he asked Silas.

"Mebbe two gallons," the old man said.

Gus grunted and, Silas at his elbow, raised the hood. He stood looking at the engine for half a minute, and then leaned over and examined the fuel pump carefully.

"Now I'll show you the thief who has been swiping your gas," he told Silas. "Stan, jack the rear end up."

Gus watched while Stan raised the rear end. When the body was at about the angle it had been on the steep hill where Silas had parked, he told Stan to stop.

"Get me a couple of gallons of gas and a good-sized pan," he directed.

Stan did as he was told. Gus pushed the pan under the engine, poured the gas into the tank, and pressed the starter button. After the engine caught, he let it run for a moment before shutting it off. "Take a look at the pump," he said.

A steady stream of gasoline came out at the pump and ran into the pan!

"There's your gas snitcher!" Gas said. "Did you have any work done on your bus just before you started to lose gasoline?"

"I had the motor gone over by a feller down in the city," Silas admitted. "He didn't charge half as much as you would have."

"Probably not," Gus agreed. "But when he cleaned the fuel pump he installed a new cork gasket and didn't center the bowl on it. That left a leak that didn't show until the car was left standing front-end down on that hill where you park it. Then the gasoline siphoned from the tank poured out of the leaking fuel pump and ran between the cobblestones without leaving any trace."

"I'll be hornswoggled!" Silas exclaimed.

"What I want to know," Jerry Corcoran said, "is how you guessed about the leak."

"Well," Gus told him, "I was sure Tommy wasn't stealing it, and as the car was being watched I didn't think anyone else was."

"How did you know Tommy wasn't stealing it?" Jerry demanded. "What was he doing with that can if he wasn't stealing?"

"You ought to have guessed that—you're a fisherman," Gus answered. "That pond at the foot of the hill is full of minnows. Last Saturday, I bought some at Jack's Sport Shop, but today the boy who catches them didn't show up. Mr. Barnstable saw Tommy going *up* the hill last Friday night with a heavy can. Last night you scared him and he dropped the empty can while he was going *down* the hill. The rest is easy."

"You ought to be on the force," Jerry exclaimed. "I've always said so."

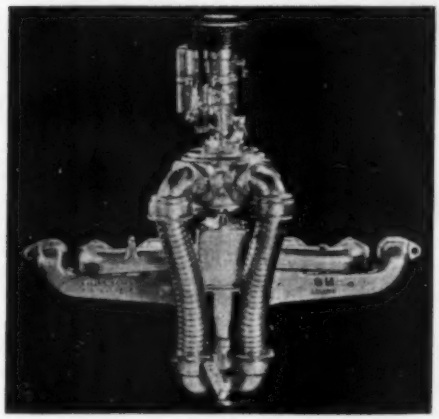
Gus turned to Lucille. "I've been thinking about Tommy. We need an errand boy."

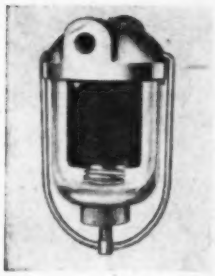
"Oh, that would be grand," she said. "I'll send him around."

"No," he grinned. "*Bring* him around."

AUTO IDEAS

EXHAUST HEAT IS UTILIZED by the unit shown below to preheat, crack, and vaporize fuel for economical operation. The device, made by the Automotive Products Engineering Co., of San Francisco, is installed between manifold and carburetor and is said to allow use of 75 percent stove oil as fuel.

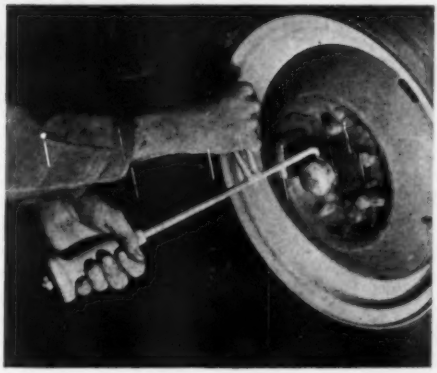




GASOLINE IS FILTERED through layers of spirally wound ribbons in the purifier shown above. The magnified cutaway at right above shows how these layers are wound in a cartridge-like filter that can be removed for cleaning. Skinner Purifiers, Inc., of Detroit, made the device for the armed forces and is now manufacturing it for civilian use. Fittings are available that adapt the filter for use not only on all cars but also on oil burners and stationary engines as well.

AN ELECTRONIC TEST of car wheel balance now permits corrections to be made without taking the wheel off the car. A stroboscope flashes at the exact moment the jacked-up spinning wheel vibrates against a magnetic pickup, and the amount of vibration, either static or dynamic, is transmitted to a dial on the electronic assembly. Correct weights may then be attached at the point opposite that shown by the stroboscope to bring the wheel into balance. The device was developed by the Stewart-Warner Corporation, of Chicago, and the kit includes a wheel spinner to turn the front wheels.

A SINGLE TOOL removes hub caps, grease caps, and inside bearings, operating simply by a light tap with the sliding handle shown being held by the left hand in the photo below. The same multipurpose utility tool is also designed to remove the rear main bearings on all cars in the Chrysler line. It is manufactured by Cam Tool Co., Inc., of Oakland, Calif.



The little tandem-seat sidecar, painted a bright red, holds the two kids, while mother and dad ride the motor scooter alongside.

"Scooting Star"

CARRIES THE WHOLE FAMILY

HAVING only a motor scooter in which to take his wife and two young children out riding, Daniel J. Wise, Jr., set about the task of enlarging his vehicle to fit his family. He purchased a surplus warplane fuel tank, converted it into a streamlined sidecar, and now has a "family car" for jaunts in and around San Diego. So well has the rig worked out that the Wises are planning some long trips in coming months.

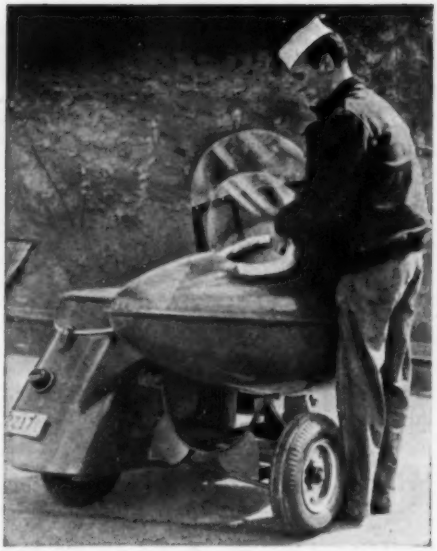
Wise obtained a droppable tank originally intended for an F6F Hellcat fighter, cut two cockpit holes in one side, and built in two cushioned seats for his small daughters. Curved windscreens were shaped from clear plastic, and the edges of the cockpits were padded in aircraft style. Working in his living room, Wise had the sidecar completed in a week's spare time.

An extra scooter wheel, some tubing, and a few lengths of angle stock made up the frame for the sidecar, with two metal cradles shaped to fit the bottom of the tank. Two bolts in each cradle hold the sidecar in place. Since the sidecar is so easily removed, Wise plans to get another tank and convert it to a single-seater for an adult passenger.

Taking inspiration from the Army's jet-propelled P-80, the Wises call their creation the "Scooting Star." On the highway their bright-painted craft attracts plenty of attention, and frequently motorcycle cops stop them —to get a closer look at their odd rig.—HOWARD E. JACKSON.

Mrs. Wise maps future family jaunts in the "Scooting Star."

The sidecar, once a droppable fuel tank for a warplane, fits into a frame built out on the scooter.



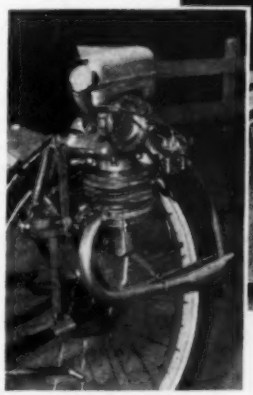
Wise lifts the sidecar and puts it in two cradles that are part of the frame. The two-seater is so light it can be put on or taken off with ease.

Two bolts on each cradle fasten the tank securely. A single-seat sidecar is Wise's next undertaking.

Aluminum Bike Motor Weighs 32 lb., Delivers 35 m.p.h. Speed

Now comes a 2-hp. aluminum gasoline engine for the bicyclist who wants a change from pedaling. Capable of speeds up to 35 m.p.h., it is said to provide smooth riding without the shimmy sometimes caused by heavier engines. Weighing only 32 lb., the unit is light enough to permit easy handling when the bike has to be lifted up curbs.

The motor is mounted in an inverted position behind the saddle with a direct friction drive on the rear wheel. It is a two-cycle engine of the mechanical-valve type and is designed to fit all standard-make bicycles. The gasoline tank over the engine is flat on top and might provide space, if desired, for strapping on packages. Reynolds Metals Co., of Louisville, Ky., makes it.



Inverted installation just behind the saddle provides direct friction drive on the top of the rear wheel itself.

Aluminum Camping Trailer Uses Landing-Gear Wheel Suspension

TORQUE-BAR wheel suspension of the type used in airplane landing gear is combined with a frame of welded steel tubing and an aluminum body to make this "Kit Kamper" trailer light, strong, and easy riding. The chassis will support 1,500 lb., yet it can be lifted by one man. Except for the roof and galley, the interior is marine plywood bonded to aluminum.

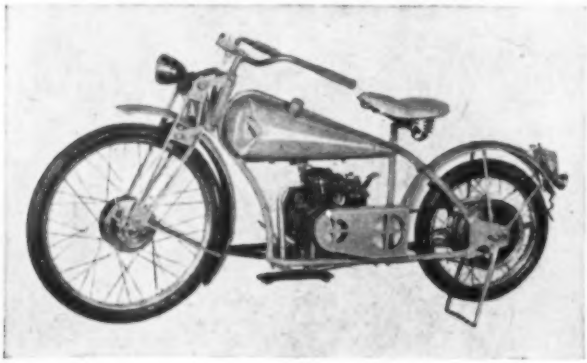
Accommodating two, the trailer has an electrically lighted sleeping compartment with full-length mattress, clothes hamper, ice box, and galley. Kit Manufacturing Co., Norwalk, Calif., is the builder.

Small Rear Wheel Provides Extra Traction For New Motorcycle

A REAR wheel much smaller than the front is a principal feature of the LaRay Power Cycle. Great increase in traction, especially on icy or slushy roads, is claimed for this departure from standard design. The new motorcycle also boasts a tension-type independent springing for the front wheel that is said to provide more shock absorbing action than the customary compression spring.

Both wheels are on dual axles so that removal of a wheel involves merely loosening one nut. The inner axle can then be withdrawn. When the wheel is put back on, alignment is automatic.

The one-cylinder, four-cycle engine delivers 1.9 hp. A fluid clutch transmits the power to a V-belt drive, and only one control, a hand-grip throttle, is required. The tank holds 2 gal. of gasoline and the engine less than a pint of oil. Current for the headlight is furnished by a lighting coil built in the engine. Brakes are a two-shoe, internal-expansion type with a molded lining.



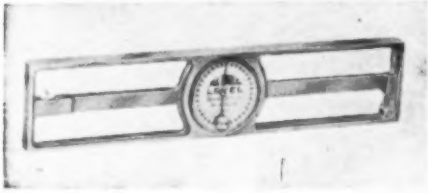
Because of the small rear wheel, the cycle has a very low center of gravity that is said to make the sitting position natural. The LaRay Engineering & Equipment Co., of Milwaukee, Wis., is the manufacturer.

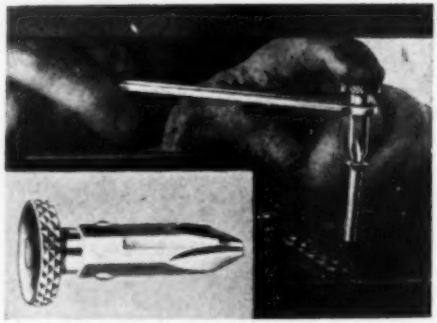
MECHANICS AND HANDICRAFT

- Your Own Handie Talkie
- Diamond-Stack Locomotive
- Drum-Disk Workshop Sander
- Checking Your Oil Burner
- Know Your Photo Filters

NEW TOOLS

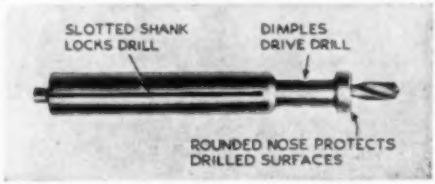
PROTRACTOR READINGS on the dial of the spirit level below permit measuring the angle of any flat surface. The 3″ by 14⅝″ level also has air-bubble tubes for horizontal use and for plumb testing. It is made by the Brand Tool Company, of Pasadena, Calif.



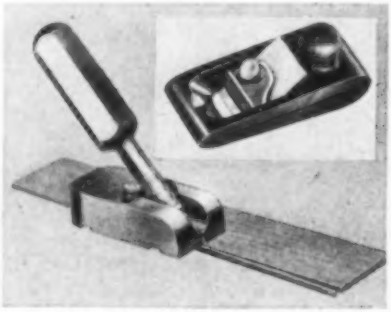


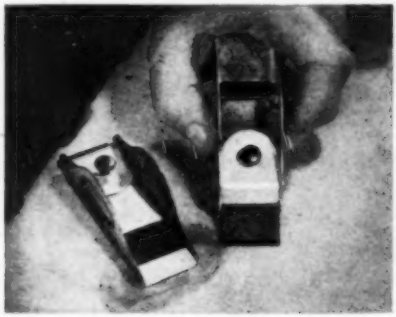
AN OFFSET SCREWDRIVER consisting of a hexagonal-wrench handle and interchangeable bits, for either recessed-head or standard screws, is produced by BMC Manufacturing Corp., Binghamton, N. Y. The handle is raised to the round neck of the bit between engagements with the hex shank.

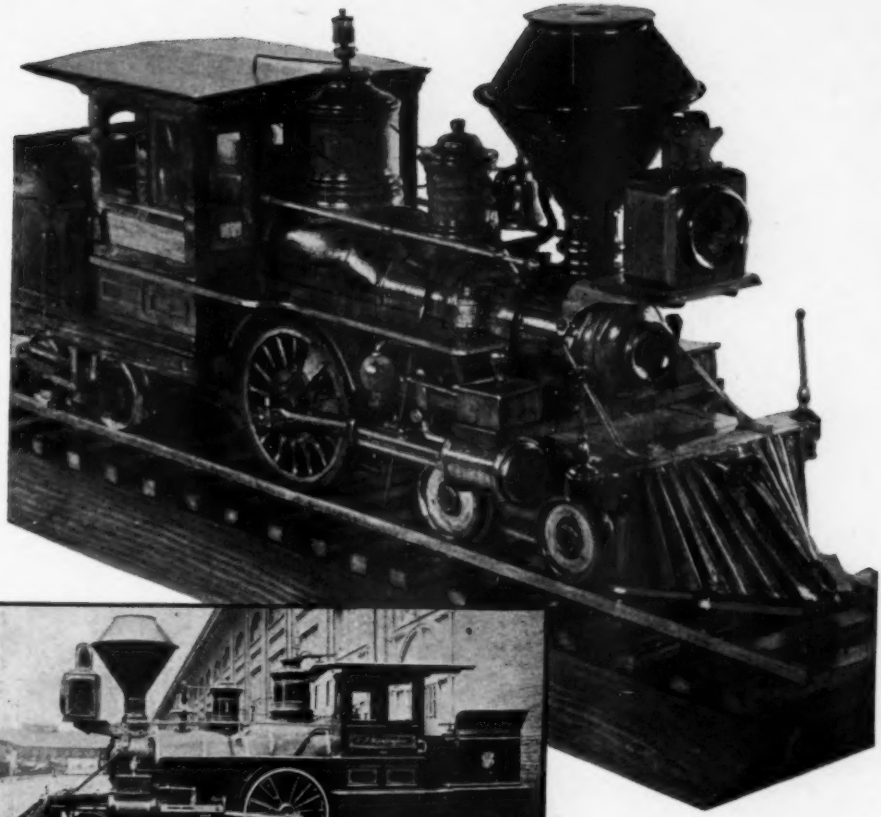
DRILL BREAKAGE is minimized by a new protector that fits over the drill and transfers stress from the shank to near the point. Made in 15 sizes by the Hartwell Engineering Company, of Los Angeles, it also can be used to gauge the depth of drilled holes and to limit bit travel through thin material.



NEW MODELMAKING TOOLS on the market include the four pictured below. At the left are a small block plane and a balsa stripper manufactured by X-acto Crescent Products Co., of New York. An X-acto knife is used with the stripper, which is adjustable to cut strips from 1/16″ to 1/2″ wide. At the right are a sander and (in the hand) a Skil-Ko combination tool, both offered by M. B. Spotts, of Philadelphia. The latter tool is shown set up for use as a gouge, scraper, or chisel. With the blade clamped in a different position, it also becomes a plane.







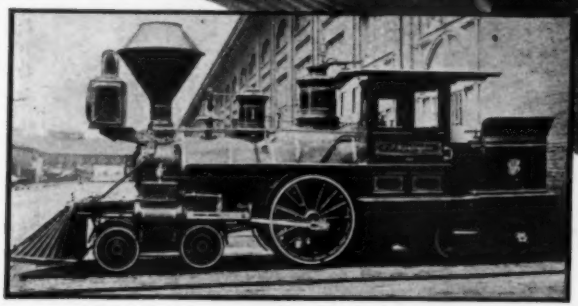


Photo Courtesy of Southern Pacific

Shipped around Cape Horn 82 years ago, the C. P. Huntington, at left, now is on exhibit in Sacramento. Above is a wooden scale model.

The IRON HORSE that went to sea

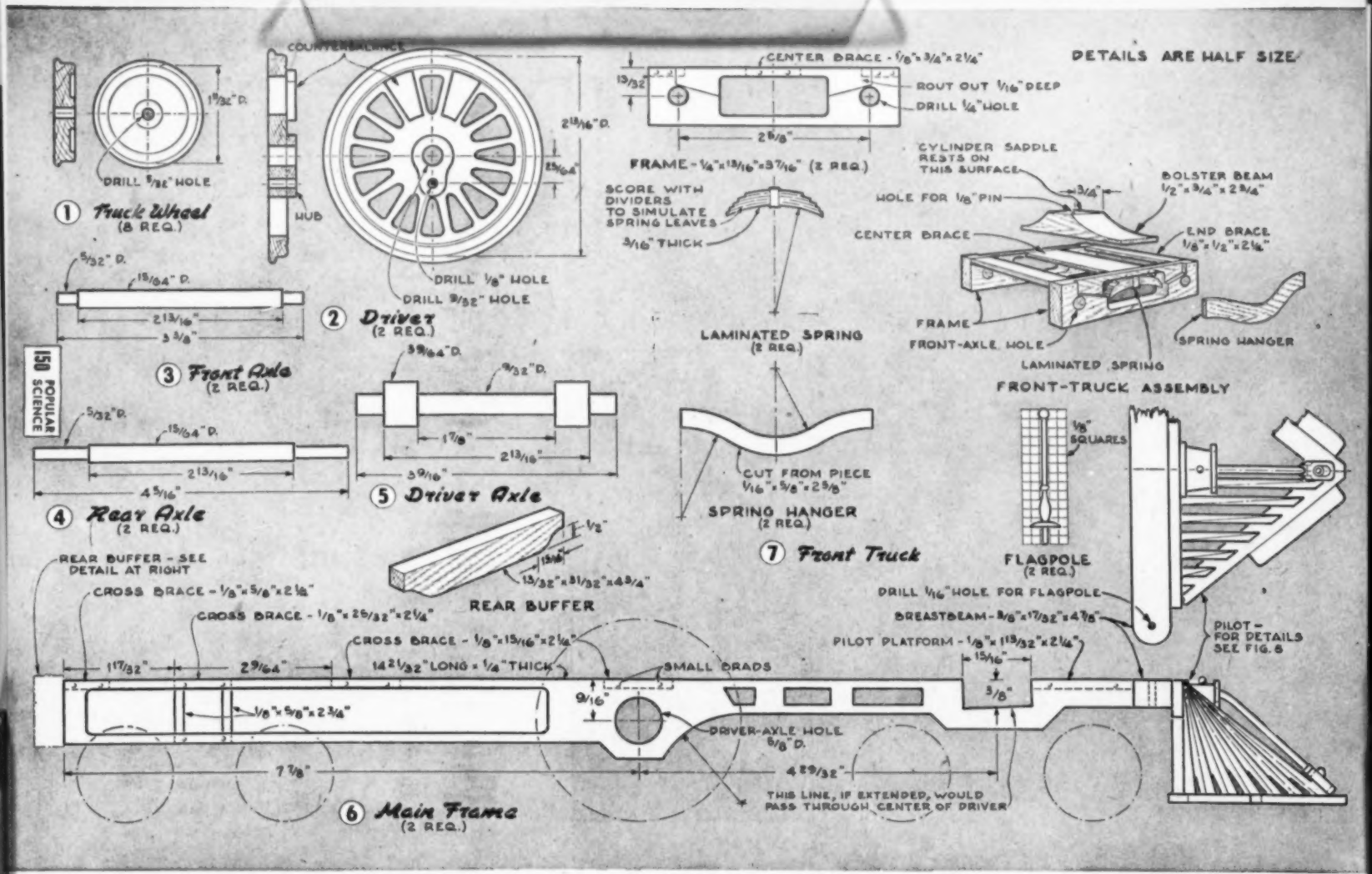
How to Build a Wooden Model of a Pioneer Diamond Stacker

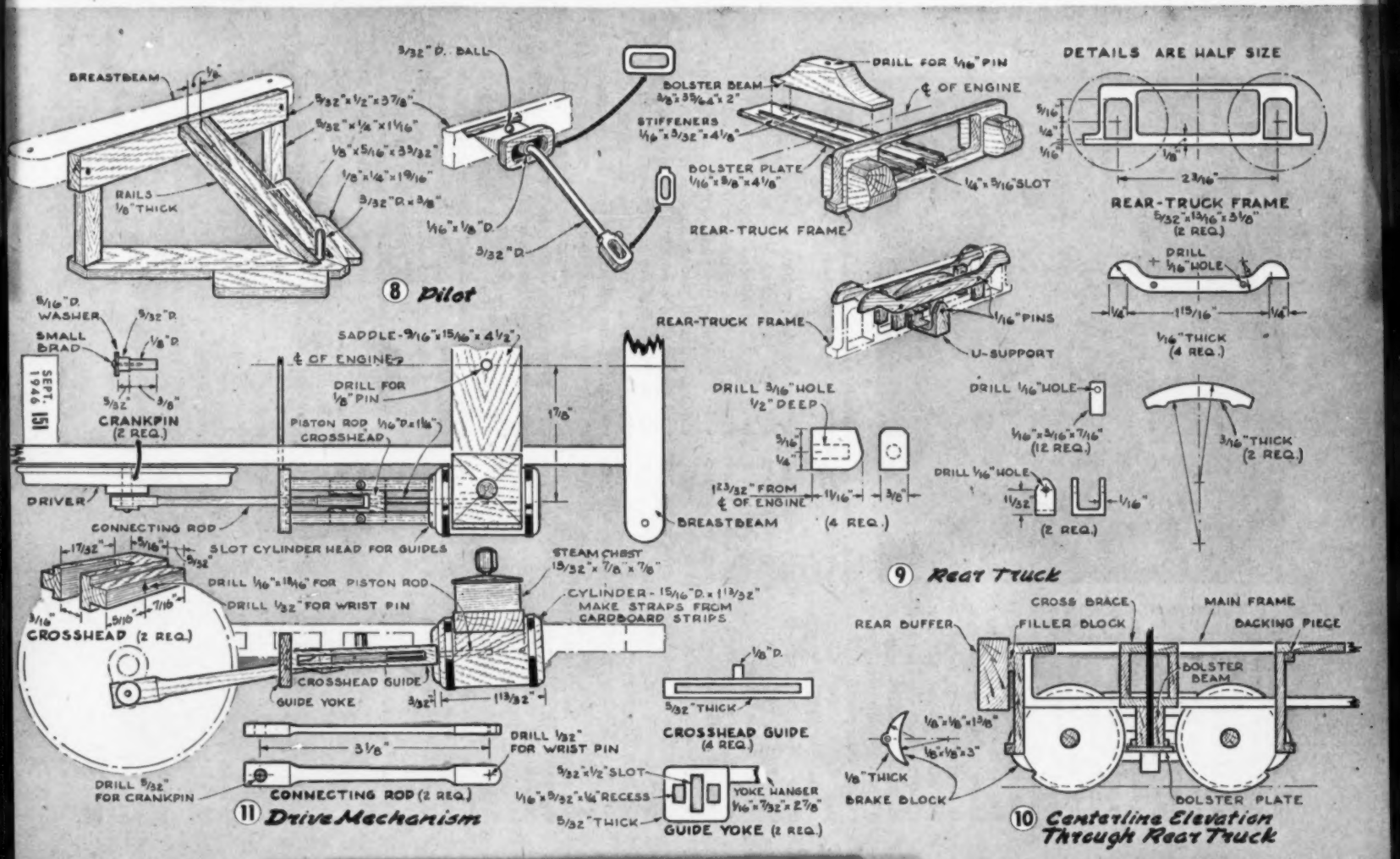
By ALFRED D. SLATER

Part I

BEFORE the first transcontinental railroad was completed in 1869, several locomotives were shipped to the West Coast by way of Cape Horn. One of the engines carried by this long sea route around South America was the now famous C. P. Huntington, a 4-2-4 diamond stacker built at Paterson, N. J., in 1863 and given its first trial run at Sacramento, Calif., on April 8, 1864.

This old wood-burning pioneer is carefully preserved today at the Southern Pacific station in Sacramento. Before being retired, it had seen the coming and going of many a new locomotive that dwarfed its 29′ length. Named for a famous railroader who helped found the Central Pacific and who later was president of the Southern Pacific, the Huntington originally went into service as No. 3 on the Central Pacific lines, but later, when the Central had become the Southern, was designated as No. 1 of the latter system, a distinction it proudly retains today. In 1920, motion-picture *(Continued on page 152)*


DETAILS ARE HALF SIZE
1 Truck Wheel (8 REQ.)
1 9/32" D.
DRILL 5/32" HOLE
COUNTERBALANCE
HUB
2 13/16" D.
25/64"
DRILL 1/8" HOLE
DRILL 9/32" HOLE
2 Driver (2 REQ.)
5/32" D.
15/64" D.
2 13/16"
3 5/8"
3 Front Axle (2 REQ.)
5/32" D.
15/64" D.
2 13/16"
4 5/16"
4 Rear Axle (2 REQ.)
39/64" D.
9/32" D.
1 7/8"
2 13/16"
3 9/16"
5 Driver Axle
CENTER BRACE - 1/8" x 3/4" x 2 1/4"
13/32
ROUT OUT 1/16" DEEP
DRILL 1/4" HOLE
2 5/8"
FRAME - 1/4" x 13/16" x 3 7/16" (2 REQ.)
SCORE WITH DIVIDERS TO SIMULATE SPRING LEAVES
3/16" THICK
LAMINATED SPRING (2 REQ.)
CUT FROM PIECE 1/16" x 5/8" x 2 5/8"
SPRING HANGER (2 REQ.)
7 Front Truck
CYLINDER SADDLE RESTS ON THIS SURFACE
HOLE FOR 1/8" PIN
3/4"
BOLSTER BEAM 1/2" x 3/4" x 2 3/4"
CENTER BRACE
END BRACE 1/8" x 1/2" x 2 1/4"
FRAME
FRONT-AXLE HOLE
LAMINATED SPRING
SPRING HANGER
FRONT-TRUCK ASSEMBLY
1/2"
15/16"
13/32" x 31/32" x 4 3/4"
REAR BUFFER
1/8" SQUARES
FLAGPOLE (2 REQ.)
DRILL 1/16" HOLE FOR FLAGPOLE
BREASTBEAM - 3/8" x 17/32" x 4 7/8"
PILOT PLATFORM - 1/8" x 1 13/32" x 2 1/4"
PILOT - FOR DETAILS SEE FIG. 8
REAR BUFFER - SEE DETAIL AT RIGHT
CROSS BRACE - 1/8" x 5/8" x 2 1/2"
CROSS BRACE - 1/8" x 25/32" x 2 1/4"
CROSS BRACE - 1/8" x 15/16" x 2 1/4"
14 21/32" LONG x 1/4" THICK
SMALL BRADS
1 17/32"
2 9/64"
1/8" x 5/8" x 2 3/4"
9/16"
15/16"
3/8"
DRIVER-AXLE HOLE 5/8" D.
7 7/8"
4 29/32"
THIS LINE, IF EXTENDED, WOULD PASS THROUGH CENTER OF DRIVER
6 Main Frame (2 REQ.)


BREASTBEAM
1/8"
5/32"x1/2"x3 7/8"
5/32"x1/4"x1 1/16"
1/8"x5/16"x3 3/32"
1/8"x1/4"x1 9/16"
3/32"D.x3/8"
RAILS 1/8" THICK
3/32" D. BALL
1/16"x1/8"D.
3/32"D
8 Pilot
DRILL FOR 1/16" PIN
BOLSTER BEAM 3/8"x35/64"x2"
℄ OF ENGINE
STIFFENERS 1/16"x3/32"x4 1/8"
DOLSTER PLATE 1/16"x3/8"x4 1/8"
1/4"x5/16" SLOT
REAR-TRUCK FRAME
DETAILS ARE HALF SIZE
5/16"
1/4"
1/16"
1/8"
2 3/16"
REAR-TRUCK FRAME 5/32"x13/16"x3 1/8" (2 REQ.)
DRILL 1/16" HOLE
1/4"
1 15/16"
1/4"
1/16" THICK (4 REQ.)
REAR-TRUCK FRAME
1/16" PINS
U-SUPPORT
5/16" D. WASHER
5/32" D.
SMALL BRAD
1/8" D
5/32"
3/8"
CRANKPIN (2 REQ.)
SEPT. 1946 151
SADDLE-9/16"x15/16"x4 1/2"
℄ OF ENGINE
DRILL FOR 1/8" PIN
1 7/8"
PISTON ROD 1/16"D.x1 1/8"
CROSSHEAD
DRIVER
CONNECTING ROD
BREASTBEAM
DRILL 3/16" HOLE 1/2" DEEP
5/16"
1/4"
1 23/32" FROM ℄ OF ENGINE
1 9/16"
3/8"
(4 REQ.)
DRILL 1/16" HOLE
1/16"x3/16"x7/16" (12 REQ.)
3/16" THICK (2 REQ.)
DRILL 1/16" HOLE
11/32"
1/16"
(2 REQ.)
9 Rear Truck
17/32"
5/16"
5/32"
SLOT CYLINDER HEAD FOR GUIDES
DRILL 1/16"x13/16" FOR PISTON ROD
DRILL 1/32" FOR WRIST PIN
3/16"
5/16"
7/16"
CROSSHEAD (2 REQ.)
STEAM CHEST 15/32"x7/8"x7/8"
CYLINDER-15/16"D.x1 13/32"
MAKE STRAPS FROM CARDBOARD STRIPS
CROSSHEAD GUIDE
GUIDE YOKE
3/32"
1 13/32"
1/8"D.
5/32" THICK
CROSSHEAD GUIDE (4 REQ.)
3 1/8"
DRILL 1/32" FOR WRIST PIN
DRILL 5/32" FOR CRANKPIN
CONNECTING ROD (2 REQ.)
11 Drive Mechanism
5/32"x1/2" SLOT
1/16"x5/32"x1/4" RECESS
5/32" THICK
YOKE HANGER 1/16"x7/32"x2 7/8"
GUIDE YOKE (2 REQ.)
CROSS BRACE
MAIN FRAME
REAR BUFFER
FILLER BLOCK
BACKING PIECE
BOLSTER BEAM
1/8"x1/8"x1 3/8"
1/8"x1/8"x3"
1/8" THICK
BRAKE BLOCK
BOLSTER PLATE
10 Centerline Elevation Through Rear Truck

audiences saw it in action in the picture "Iron Horse."

This wooden model of the old wood burner was built from diagrams and information furnished by D. L. Joslyn, author of a history of the Huntington. In general, all parts are accurately scaled, but where strict adherence to such dimensions would result in parts too tiny for easy handling the parts have been made somewhat heavy. This applies particularly to such items as the axles, frames, and the running-board bracket. How the model appears when completed is shown in the color photograph on page 120.

All the parts of the driving mechanism are carefully simulated. The cylinders incline downward toward the rear for proper alignment.

You should find it easy to turn the truck wheels (Fig. 1) and the drivers (Fig. 2). Fasten the stock with three No. 19 wire brads to the trued face of a backing piece mounted on the lathe faceplate. For the drivers, take care to locate these brads between spokes. After the wheels and drivers are turned down to the indicated outer diameter, simulate the tire by making a V with the corner of a chisel.

Drill a hole in the corner of each waste section between the spokes of the drivers and remove the excess material with a coping saw. Then file and sand the spokes smooth and glue on the hub and counterbalances. The crankpin holes should be drilled on a drill press.

Expand the ends of the axles (Figs. 3, 4, and 5) into the wheels and drivers by pounding small brads into them. The main frames (Fig. 6) are cut from single pieces of wood and are held rigid by cross braces, the pilot platform, the breastbeam, and the rear buffer, the latter projecting 1/16″ above the frame top. The frames of the actual Huntington are made of bars 1¼″ by 4″, but when scaled down to model-building size this would be too small. In cutting the slot for the cylinder saddle, note that the bottom is inclined toward the rear so as to give the cylinder itself a similar tilt.

The front truck frames (Fig. 7) are assembled in the same manner as the main frames. Dap or recess the outside of the frames to accommodate the 1/16″ thick spring hangers, which are glued in place after the semielliptical laminated springs have been mounted. The leaves of the springs may be simulated with dividers.

In assembling the pilot (Fig. 8), begin by cutting out and gluing up the framework; next add the rails, and finally make and apply the front-coupling mechanism. Note that the front face of each rail is cut to a full chamfer at the bottom and that this chamfer reduces to nothing at the top.

When you are assembling the rear truck (Fig. 9), pass the inner leg of the U-shaped support through the slot in the bolster plate. Attach the rear truck as in Fig. 10.

The 15/16″ dia. concave surfaces of the saddle against which the cylinders are seated (Fig. 11) may be formed by first removing most of the material with a saw and then pressing the surfaces against fine sandpaper wound on a lathe-driven mandrel of the same diameter. Screws passing through the main frames hold the saddle secure.

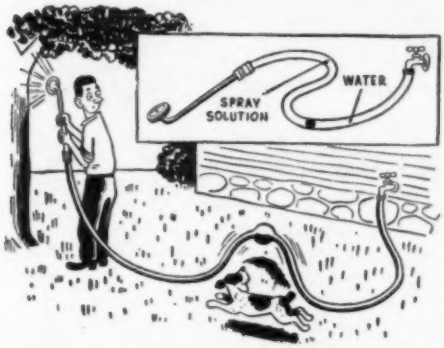
Small brads are used to expand the crankpins into the drivers the same way they were employed in the axles. The crosshead either may be fashioned from a solid piece of wood or built up of three pieces. Note that the piston rod is glued into a hole in the front end of the crosshead. The four crosshead guides slip into slots in the cylinder head and the yoke, and the yoke is suspended by a hanger attached to the main frame.

[To be continued.]

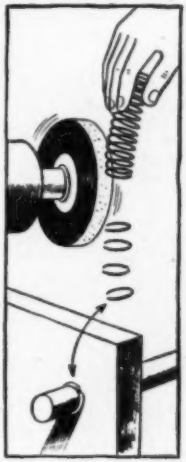
What's Your Ingenuity Quotient?

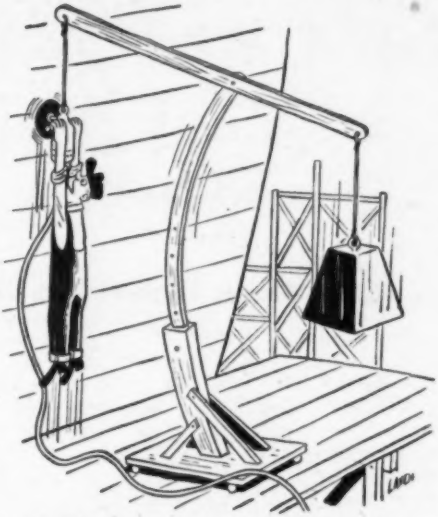
Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.

INSECTS CAN'T COUNT, so they attacked my few trees as if they had an orchard to feed on. Instead of buying a sprayer, I filled a garden hose with spray solution, and slipped in a wooden ball. Faucet pressure drives the spray through the hose. The flow shuts off when the ball is pressed against the nozzle.—J. V. Kopp.



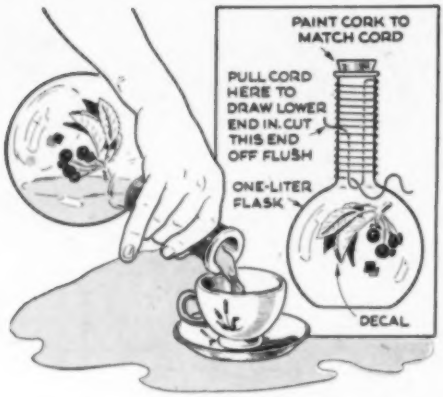
DROP TWO LETTERS, and "spring" becomes "ring." Anagrams won't keep a machine running, but when I lost a badly needed retaining ring, I found that my grindstone could erase the extra letters quickly. I made a batch of new rings in a jiffy from a coil spring of the proper gauge wire. The diameter of the coil has to be slightly smaller than the groove the ring is to fit, since the open loop tends to spring outward a bit.—J. L. Cole.





SANDING A SHIP is no fun when it means holding a pneumatic disk sander, plus twelve feet of air hose, practically overhead for hours at a time. I lightened my work considerably with this load-lifting idea for counterbalancing the sander on a free-moving, adjustable pivot.—S. Fenster.

THERE'S A STRING TO THIS ONE. It happened when my windshield wiper conked out suddenly, leaving me high and wet at the start of a rainy trip. A string tied to the blades and looped through the front windows kept 'em moving, with me pulling the string from inside.—R. J. Ulliny.



Lab Flask Serves Hot Coffee

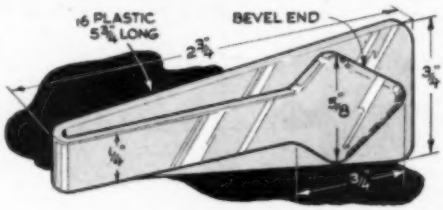
One of those long-necked, clear laboratory flasks of heat-resistant glass can be made into a graceful hot-coffee server. Choose a flask of 1-liter capacity. It holds almost a quart, which should be sufficient for six fairly large cups.

Wind a stout cord around the neck for a handle and fit in an ordinary cork stopper. The cord may be in a bright color, if desired, and the cork painted to match. A decal on the body adds a finishing touch.

After preparing the coffee as usual, pour it into the flask and keep it hot over a low flame until served.—Barbara S. Duffy.

Clear Plastic Formed into Unusual Crystal-like Tie Clasp

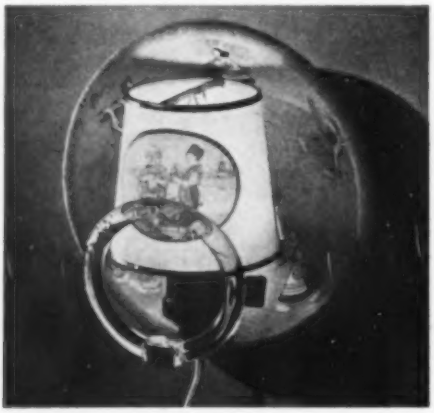
For a tie clasp that will bring admiring glances, cut and bend a strip of lucite or plexiglas to the shape shown. Taper the piece from ¾″ to ¼″ at the arrow, smooth the edges with fine sandpaper, and bevel the arrow so it will slip on the tie easily. Heat to 300 deg. F. in an oven, remove with gloves, and bend.—Frank Shore.

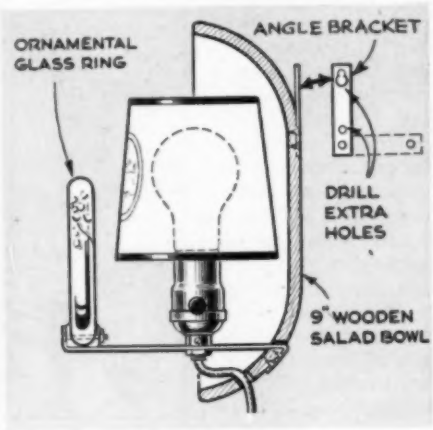


Pin-Up Lamp Is Made of Simple Materials from Dime Store

This little lamp is designed for the wall of a bedroom, den, or dinette. Materials needed are a 9″ wooden salad bowl, a light socket, a nipple and nut to fit the socket, a small shade, 6′ of cord, a plug, a flat brass angle brace, and a glass festoon ring with its bracket—the kind used in hanging drapes. All were bought at a single 10-cent store.

Mark a centerline to work from on the back of the bowl, and slot and drill it as shown in the drawing below. The festoon bracket is drilled for the light-socket nipple, inserted in the slot, and bent as indicated. Saw a leg from the angle and drill for a hanger. Scrub the waxed bowl thoroughly if it is to be painted.—Earl Pease.



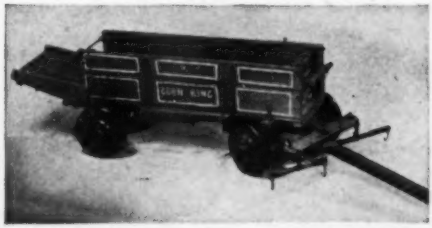


CRAFTSMEN at WORK

DIME-STORE MATERIALS, along with a carved white-pine hull and 800 hours of work, went into this model of the *Flying Cloud* made by John H. Rieger, of Erie, Pa., from POPULAR SCIENCE MONTHLY blueprints. Fishing line was used as rigging.

THIS HUSKY JIGSAW with a 30″ throat and a stroke adjustable up to 6″ for cutting both metal and wood was built by Joseph F. Zima, of Stratford, Conn., at a cost of $12 exclusive of the motor. The frame is 3″ steel pipe. An old Packard compressor is used as a blower.

MOTORIZED PAPER DELIVERY is the idea of Daryl Baker, of Russell, Kan., a 12-year-old newsboy. There's nothing fancy about Daryl's contraption. He made it by hammering together an oak frame, assembling bicycle wheels on it, and installing a motor from a washing machine. But it's better than walking or pedaling, and he gets 100 miles to the gallon of gas and can drive it at 30 miles an hour.



FARM WAGONS IN MINIATURE are made by Raymond Coe, of Kensett, Iowa, as a hobby and for profit. The model shown above and below is complete with box body, hinged and chained backboard, yoke, and doubletree. Scrap lumber, including peach-crate stock for the box, was used throughout for wood parts. The wheels were cut out with a compass saw, and then mounted between centers in the lathe for turning to simulate rubber tires. Irons holding the backboard came from an old electric plug.

TRIAD...A Radial-Wing Flying Model

By ROY L. CLOUGH, Jr.

DESIGNED with radially mounted wings as found on some robot bombs, this novel model has brought favorable comment wherever it has been flown.

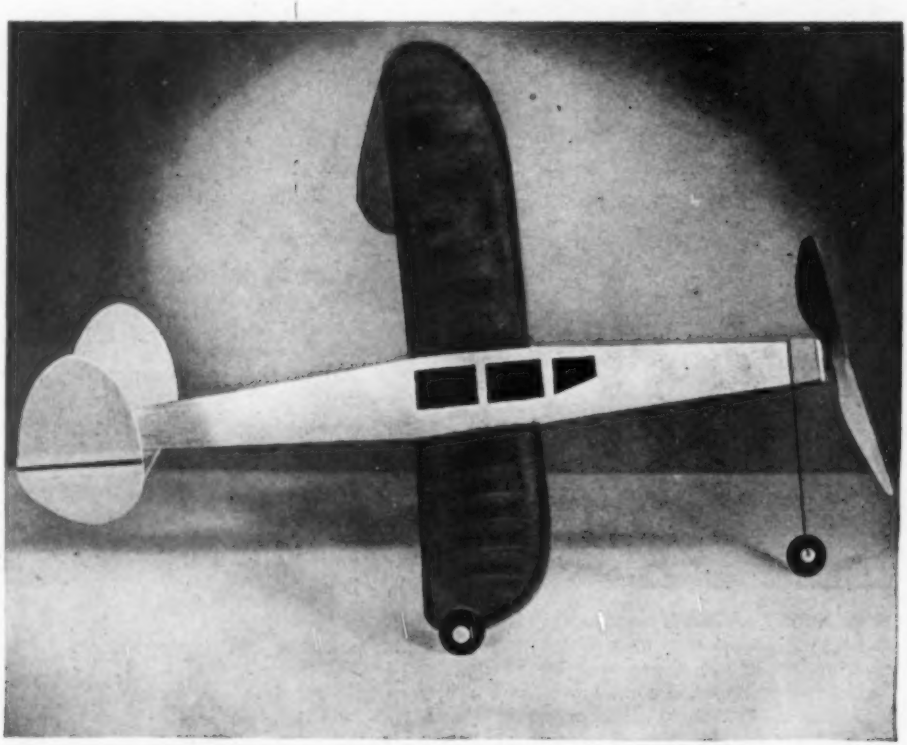
Its surprising stability is due directly to the vertical wing. In straight and level flight, lift is provided by the two lower wings. Should the model tend to bank in either direction, the vertical wing will exert lift and return the ship to an even keel. In fact, turning and banking can be controlled entirely by warping the single aileron on this vertical wing.

Construction is extremely simple. The fuselage is built up of three sheets of 1/32" medium-hard balsa, all cut to the same shape. Stiffeners of 1/16" square balsa are cemented to the inner faces of these sheets. The nose end is reinforced with plates of 1/16" balsa, cemented on after assembly.

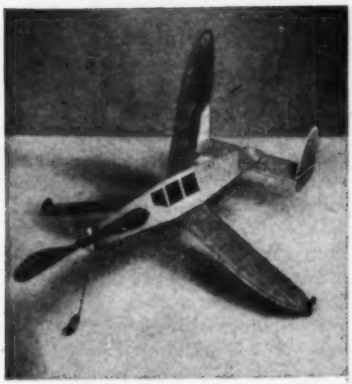
Cut three identical wing frames from 1/16" medium soft balsa and install the 15 ribs, trimming a little from the trailing edges of the outer ribs to make them fit. Cover with regular model tissue and water-shrink, but do not dope.

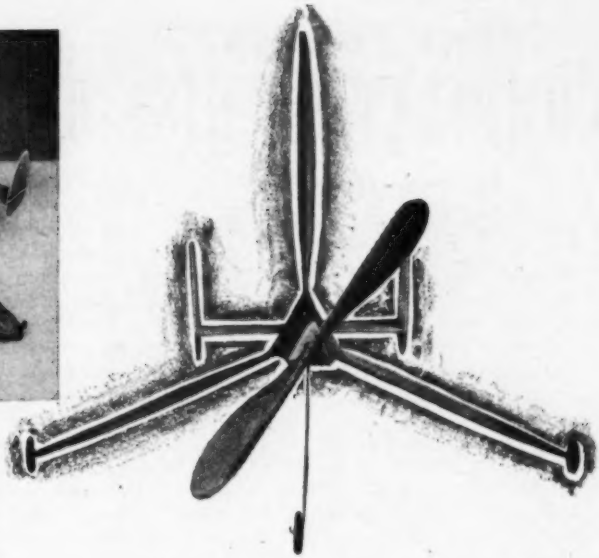
A shallow groove cut chord-wise in the butt edge or root of each wing will make a stronger joint. Use cement liberally to attach the wings to the fuselage. The two lower wings, which take up the shock of landing, are reinforced with wire crosspieces as shown on the plans.

A notch in the elevator, reinforced by an additional thickness of stock, retains the rear rubber hook. Mount a wide-bladed prop of fairly high pitch and make test flights over tall grass on a calm day. The sturdy fuselage permits use of a powerful enough rubber motor to give the ship a skyrocket climb.



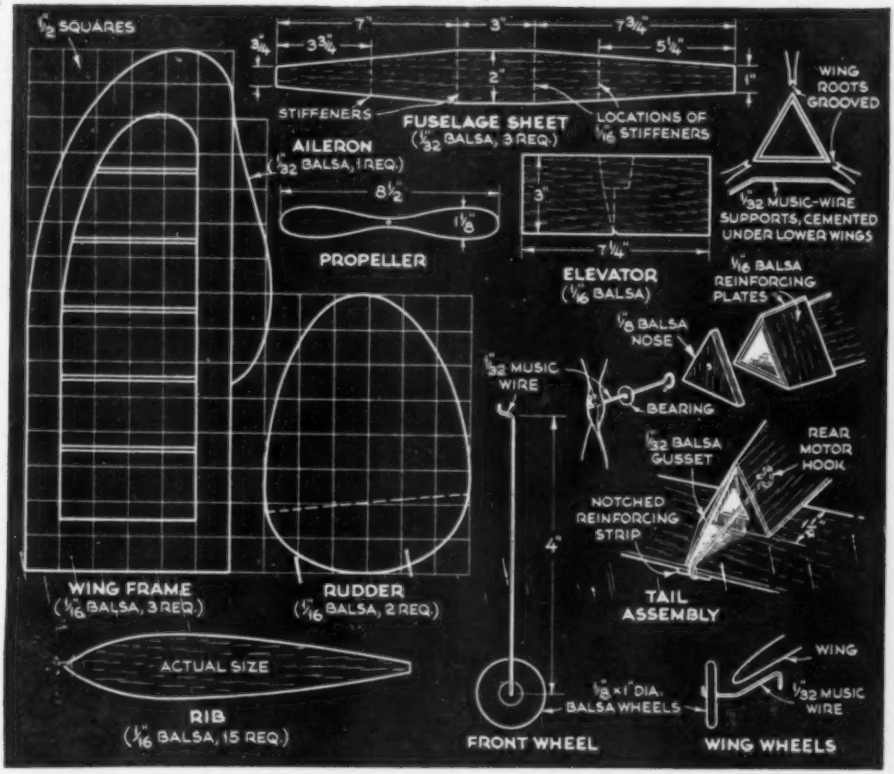
An interesting experiment in radial-wing ships, this model is incapable of stalling out of a climbing turn.





A nose wheel helps preserve the prop from damage. Performing much like a high-pylon design, the plane climbs to the right and glides to the left.

Wing design makes for speedy construction. The aileron shown on the plan is fitted to the vertical wing only. Other wings have landing wheels at their tips.



HOW TO MAKE A

COMBINATION DISK-DRUM SANDER

By Frank McCarty

DESIGNED to take a standard 6″ by 48 5/16″ abrasive belt, this home-workshop combination power sander is constructed almost entirely of ¾″ plywood. Belts can be changed quickly by means of a simplified belt-tension control. A sanding disk, complete with tilting table and miter gauge, is also provided for accurate end and miter sanding.

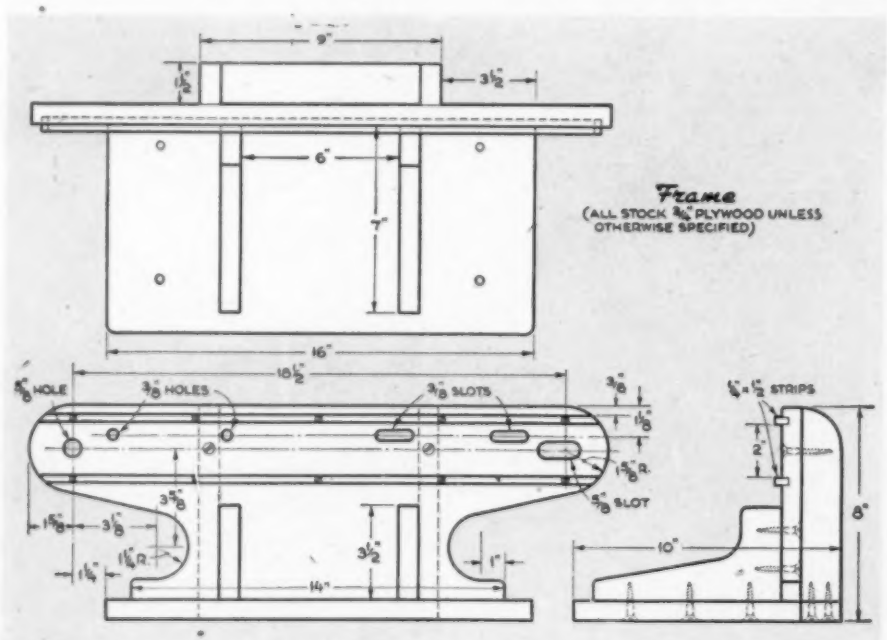
Lay out all parts full size on paper by following the dimensions on the drawings. Trace the patterns on ¾″ plywood and saw out the parts. Drill all the bolt holes next, as indicated. Then cut out the slots as shown, taking care to locate them exactly as specified. The grooves for the guide rails in the frame upright and in one side of each drum carrier are best cut at the same settings of the circular-saw fence to assure alignment.

The frame consists of a baseboard, an upright sawed out to the contour shown, and reinforcing brackets on both faces of this piece. It is assembled with glue and flathead wood screws, and the guide rails are similarly attached, with all screw heads well countersunk.

Both drum carriers are identical except that one is left-handed and the other right-handed. With an expansion bit, or a circle cutter, make holes into which generator-type ball bearings for a ½″ shaft will fit snugly. Retainers cut out of ⅛″ pressed composition wood prevent clogging by sawdust. They can be removed for occasional greasing. Each inner retainer is turned down to fit in the ball-bearing hole. Bearings will automatically line up when a ½″ shaft is pushed through.

The carrier on the left is permanently attached to the upright on the frame by two ¾″ by 2″ carriage bolts, while the carrier on the right is to slide on the guide rails, being held to the upright by two bolts that can be moved in the slots. Heads of the bolts are ground flat for clearance.

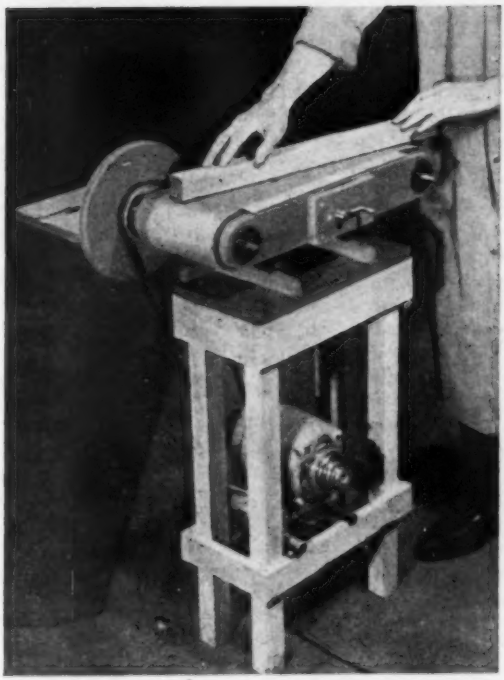
Hardwood wedge blocks between the two



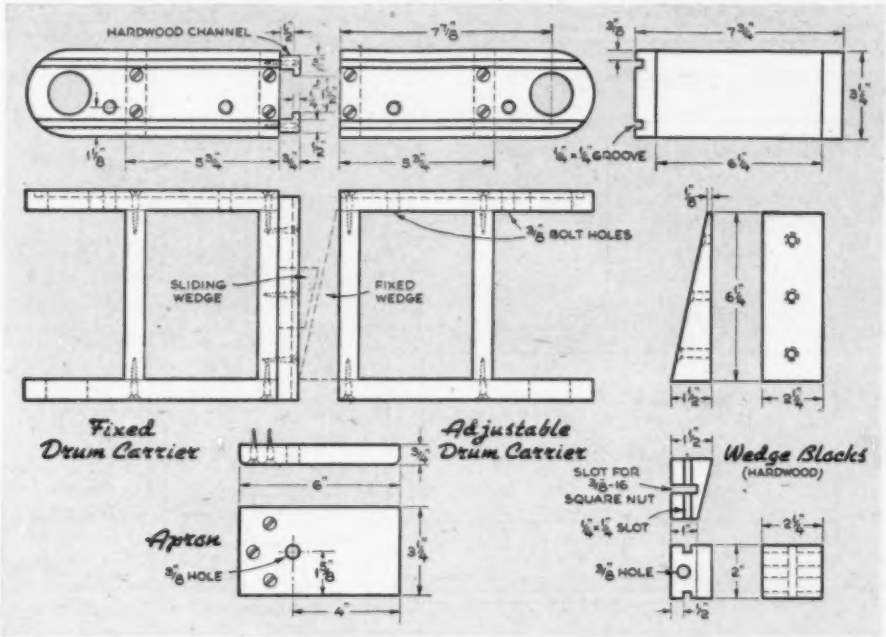
carriers provide for tightening the sanding belt and also for loosening in order to change it. The adjustable carrier has its wedge permanently attached with countersunk screws, while that on the stationary carrier slides in hardwood channels. This wedge is drilled through from end to end with a ⅜″ drill and slotted across the hole to receive a ⅜″-16 square nut. Then a ⅜″-16 threaded rod is pushed through and threaded into the nut.

The other end of the rod passes through a plywood apron attached to the stationary carrier by screws. With a crank handle pinned on the end of the rod (a junked one from an auto window will do) and two check nuts tightened behind the apron, the carriers can be moved apart for tightening the sanding belt. Be sure to loosen the bolts through the upright before attempting the adjustment, and then tighten them again to hold the carrier in place.

Eight 4⅛″ diameter pine disks are glued and nailed together with the grain alternating at right angles to form each of the two drums. Seven



A sanding belt running on drums and over a supporting table removes excess stock quickly and produces a smooth finish.



of the disks have ½″ holes in the center, and one end disk has a slightly larger hole to accommodate the collar of a ½″ shaft. For gluing, all eight are assembled on the ½″ shaft, but this is removed before the glue sets. Drill the drum near the end for a 1½″ long setscrew to be put into the collar. This locks the drum to the shaft. When the sander is mounted on its stand and the drum shaft of the stationary carrier is connected to a motor by means of V-pulleys and a belt, the drums can be turned to their 4″ diameter, as indicated in one of the photos. One drum is turned first, and it is then replaced with the other.

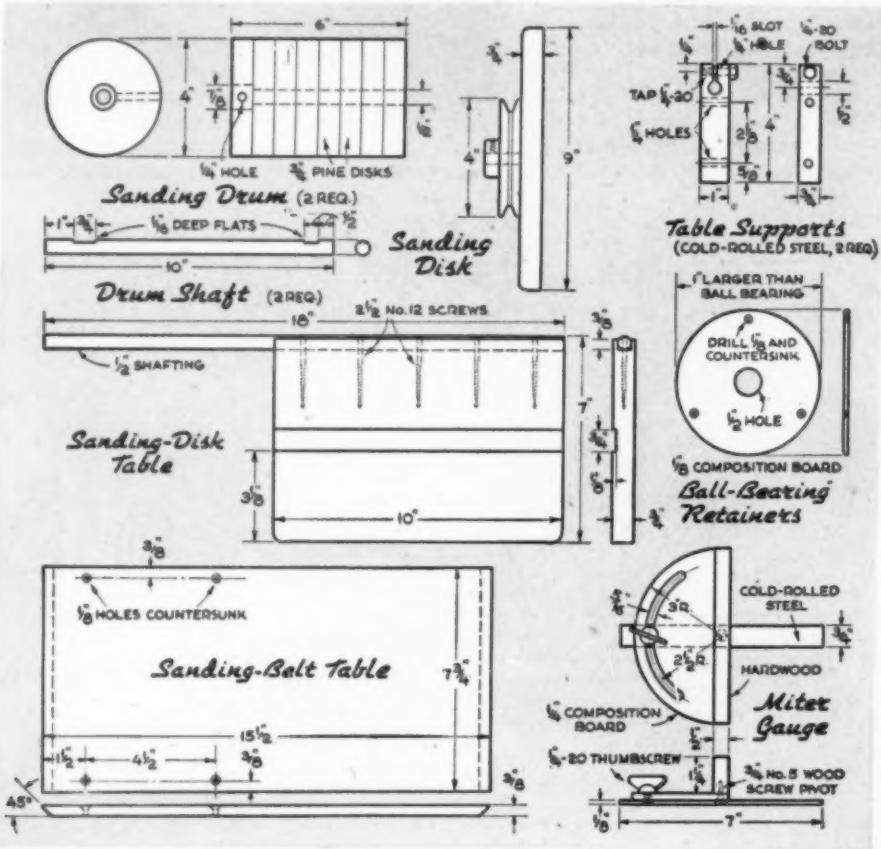
The sanding disk is a plywood faceplate fastened to the driving pulley by wood screws through holes drilled in the hub. It, too, can be trued up with a chisel when mounted in its regular position on the sander and turned by the motor.

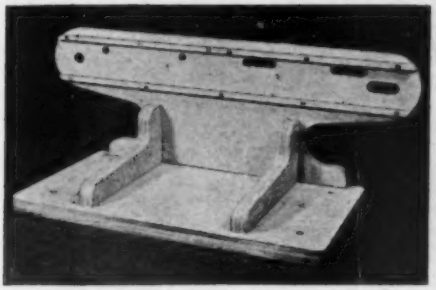
Groove one edge of the sanding-disk table to receive a length of ½″ shaft, which is firmly attached to it with five flathead wood screws. Countersink the holes in the shaft. Split-bushing blocks on the two back brackets of the frame hold the shaft in place and permit it to be locked at any angle. The table can be quickly removed for renewal of the sanding disk by loosening the bolts in the bushings.

A simple miter gauge is arranged to slide in a groove cut in the top of the table. For a thumbscrew to tighten the gauge at any angle, use a bolt with a wing head or solder a flat piece of brass in the slot of an ordinary roundhead bolt.

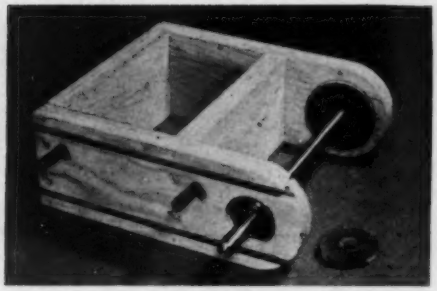
Make a support for the sanding belt of ⅜″ plywood and fasten it under the belt to the stationary carrier only. This prevents sagging during use.

The sanding machine may be used on any

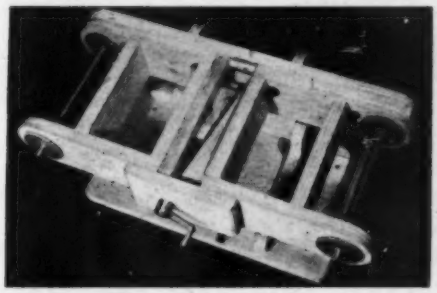




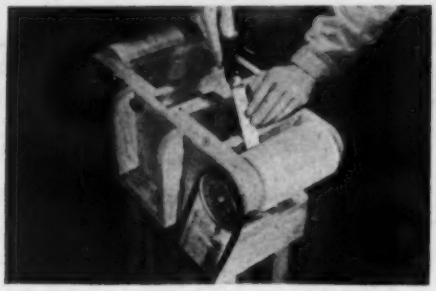
Assemble the frame of parts cut from ¾" plywood, using glue and screws, and attach carrier rails.



Holes in the drum carrier are a snug fit for the ball bearings, which are protected by retainers.

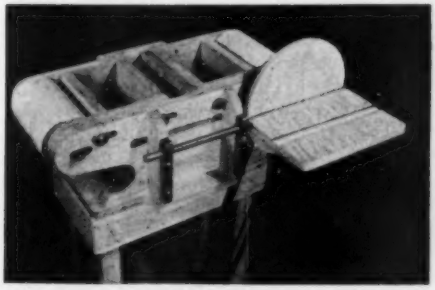


Tension for the sanding belt is provided by this arrangement. A threaded rod, turned by a handle, wedges tapered blocks to push the carriers apart.

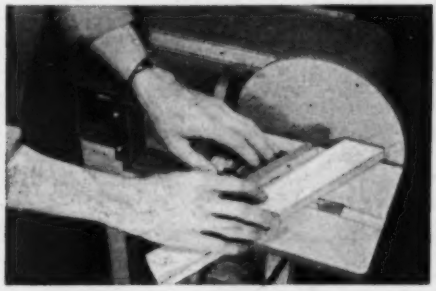


With the machine mounted on its stand and driven by the motor, the drums can be turned to diameter one at a time on the driving shaft as in a lathe.

By loosening two bolts in the split bushings, the sanding-disk table can be adjusted to any angle.



A miter gauge slides freely in a slot in the table top to provide for accurate sanding of end joints.



kind of stand that is convenient, or one may be made like that shown in one of the photos. This consists simply of four sturdy legs with a frame top and rails of 1" lumber. The base of the sanding machine is bolted firmly to the top at the corners, as indicated in the photo, while two of the rails serve as a support for the motor. A setup like this will put the motor shaft in line with the drive shaft of the machine so the pulleys can be connected easily with the driving belt.

Finish the sander with machine-gray paint for a factory-made appearance, but leave the belt support, the sanding-disk table top, and the face of the sanding disk plain or, if preferred, just put a coat of shellac on them. Rubber cement, which can be removed readily, is an excellent adhesive for holding the abrasive sheets on the disk. For best results in operation, run the sander at motor speed (1,750 r.p.m.) by using a 4" pulley on the motor as well as on the drive shaft.

When the first ridge board with supporting rafters has been raised, a house takes on definite character.

Framing a Straight Gable Roof

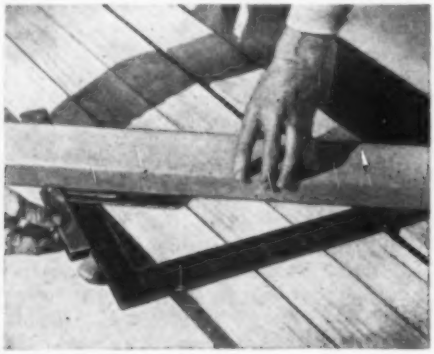
FOURTH OF A SERIES

By Edwin M. Love

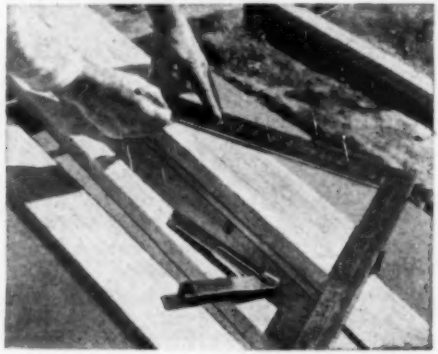
THE roof of a building is second in importance only to the foundation, and it should be well framed of sound material. If possible, use only No. 1 grade lumber for the rafters. When poorer lumber is all that can be obtained, place the weak rafters at the gables and partitions where there is ample support from studding or braces, reserving the soundest pieces for places where the rafters bear the burden alone.

Make a pattern rafter by which to mark the others. Carpenters have several practical ways of determining rafter length, but a foolproof method is to scale from a drawing of half the roof span made on a wide board. Use a scale of 1½" equal 1′, as shown in Fig. 1. From such a scale, desired lengths in feet and inches are easily measured.

Setting a bevel square for a rafter end cut. The straightedge and framing square indicate the rise.



Laying out the projecting end, or "lookout," of a rafter. A gauged line is drawn for use as a base.



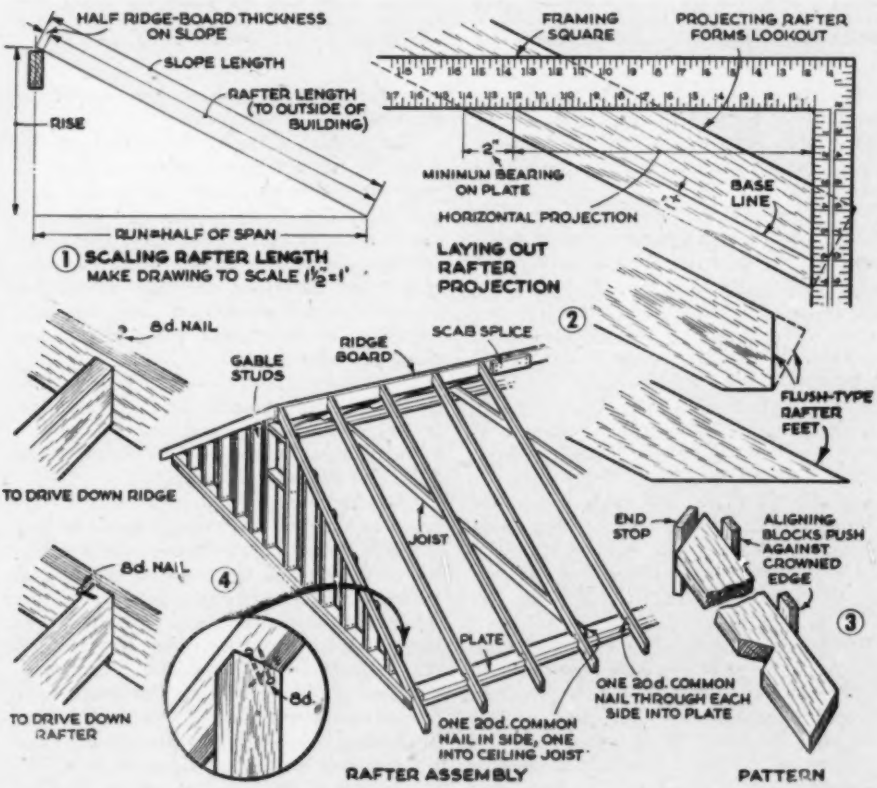
The hypotenuse of the triangle represents the slope of the roof, and this length minus half the thickness of the ridge board along the slope is the length of the rafter to the outside of the building. (See P.S.M., Nov. '43, p. HW539, and Dec. '43, p. 146.) If the rafter is to project beyond the building as a "lookout," find the additional length by laying the framing square on the pattern with the tongue at the lower end, as in Fig. 2 and the photo at the lower right on the facing page. The blade reads for the horizontal projection and the tongue for the corresponding rise. For ease in reading, gauge a pencil line on the side of the rafter for use as a base line.

Obviously the notch should be no deeper than necessary since it weakens the rafter. The horizontal bearing on the plate, however, should be at least 2" long.

Set a bevel square to the angle of the end cuts, as shown in the bottom left photo on the facing page. Then, after the upper ends have been cut, lay six rafter pieces on sawhorses, as in the photo at left on page 164, with the crowned edges on the same side and mark them one at a time with the pattern. The latter, shown in Fig. 3, should have a stop at the upper end and aligning blocks along the upper edge. Cut all rafters with the crown, if any, on the upper side.

Rip the horizontal cuts for the notches first, as in the photo at right on page 164, and complete the cutting with a crosscut saw. If the lumber is rough and the lookouts are to be smoothed, sit astride and dress the sides and lower edges with a jack plane. Lay the finished rafters neatly in a pile to keep them straight. Many carpenters prime the lookouts as soon as the rafters are made, as it is easier to paint them on sawhorses than after the roof has been completed.

If you wish to check the rafter layout, cut a pair and lay them on the floor with the



Marking a rafter with the aid of a pattern, which has an end stop, aligning blocks, and a notch to make certain that each is cut in exactly the same way.

Notches fitting over the plates are ripped first for the horizontal cut, as above, after which the vertical cut is made with a crosscut saw.

lower ends against a sill and the upper ends separated by a block the thickness of the ridge board. Measure the distance between notches, which should of course, equal the span of the roof.

Before attempting to raise rafters, build a working platform on the ceiling joists at the center. If the joists are 16″ on centers, 1″ boards laid on top, as in the upper photo on page 162, may be sufficient. But if the span is wide, and especially if the joists are spaced 4′ or more apart as in a garage or shop, shore the joists up from beneath with 2″ by 4″ or 2″ by 6″ planks supported by 2″ by 4″ posts, and lay 2″ planks or two thicknesses of 1″ sheathing for walks. Drive enough nails to tie the assembly together.

Lay out the plates and ridge boards for rafter spacing, say 2′ center to center, using the blade of the square as a gauge. It usually pays to shift the rafters, if necessary, to permit spiking to ceiling joists for ties, as shown in Fig. 4.

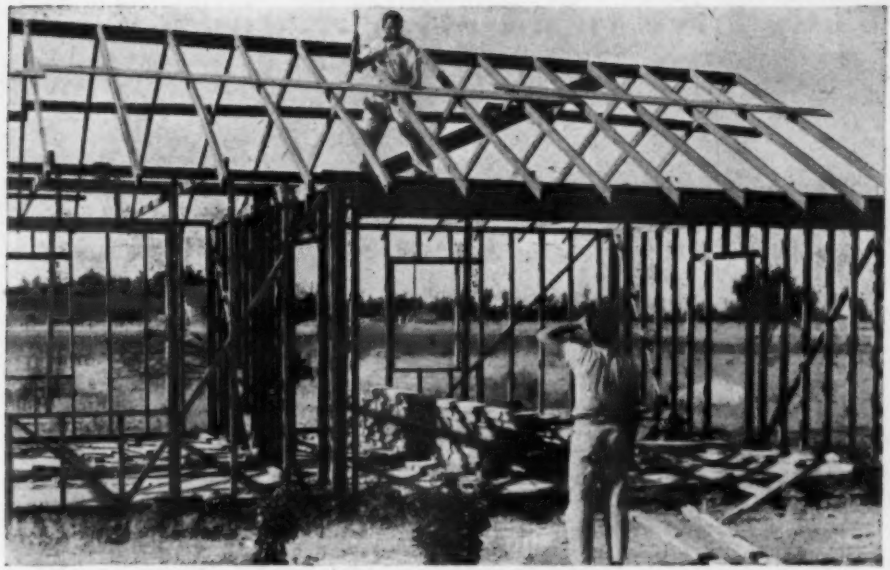
Rafters are often stood on end around the building, to be pulled up by a man standing on the plate. A workman doing the job alone will find it convenient to lean them against the center platform, lift the other ends and rest them on the head trimmers of window and door openings, and then slide these ends onto the plates by pushing them up with a short piece of two-by-four.

The method of raising the rafters will depend on the number of men working. If there are two helpers, nail a rafter near each end of a ridge board at one side and have the helpers lift the board until the rafter notches seat and are nailed. Then nail corresponding rafters on the other side. This assembly is self-supporting, and one man can work at the center while others nail along the plates.

One man working alone can prop up the ridge board and brace it. Tack the four supporting rafters to the board, nail them solidly to the plates at the notches, and complete the nailing at the ridge board.

Since the second ridge board can be fastened to the first, the raising of this section is a little easier. Leave the last pair of rafters unnailed until the starting end is plumbed with the building; then plumb a mark on the ridge board at the other end and nail rafters there. This corrects for errors in "stepping off" with the square in spacing.

Space gable studs from the window or louver vent in the center. One stud having been fitted for a side, the others can be cut by reducing the length from that of the previous stud 1½ times the rise per foot for



Rafters are straightened after being nailed down. While a helper sights along a crooked rafter, the bow is pushed out and the rafter tacked to the spacing board. Sheathing is then brought up and the aligning board removed. The sheathing itself will level most of the crown or sag of the rafters.

16" spacing. Sight along the end rafters and straighten them by the placing and nailing of studs.

This done, lay sheathing boards across the rafters about midway, as indicated in the photo above, keeping them from sliding off by driving nails into the rafters along the lower edge. Have a helper on the ground sight the rafters, and spring them sideways to straighten them, holding them by driving 8d. nails part way in through the boards. These remain in place until the sheathing is brought up to them. Most of the crown or sag of rafters is leveled out by the pull of the sheathing boards as they are nailed.

Rafters, instead of projecting from the building, may be cut off in a straight horizontal line to rest on the plates with the upper edges meeting the plates, or the ends may be cut on the vertical at the notch. Ceiling-joist corners projecting above the rafters are chopped off, as at right, to clear the sheathing.

The rafter assembly can be braced by nailing sheathing boards diagonally across two or three corners. Keep such braces high enough to allow sheathing to be extended for some distance above the eaves before they must be taken off.

Subsequent articles in this series will complete the shingling of the roof and deal with preparations for stuccoing, installing door and window casings, finishing the inside walls, and completing the interior.

Corners of ceiling joists must be chopped off flush where they project above the upper edge of rafters at the plate.

They Live in a Cellar ... and Like It

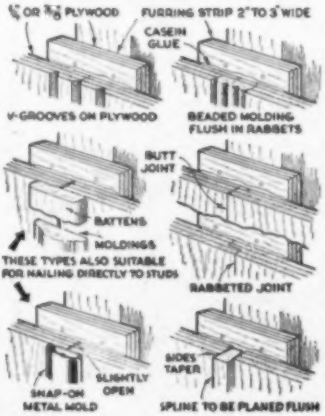
This comfortable apartment, with 12' by 20' living room and bath and kitchen adjoining, once was a storage basement. Below, tenants-to-be watch a carpenter install mineral-wool insulation and wallboard. The fireplace also is new.

DO YOU have unused space in the basement of your home? If so, it may be possible to convert it into much-needed living quarters in these days of housing shortages.

Here is an example showing how one enterprising home owner remodeled a ground-level basement area into a small apartment for a veteran and his wife. Previously the space had been used only for storage. Remodeled at a cost of approximately $750, the basement now is bringing the owner a modest income in rental.

Since the work was done to accommodate a veteran, the owner was able to obtain a priority for materials. Government-insured loans also are available for such improvements.

JOINING PLYWOOD WALLBOARD [WOODWORKING]

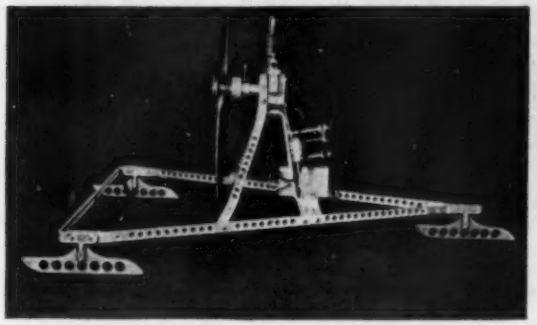


Closed-joint installations of interior plywood wallboard are of two classes: those which emphasize the joints, introducing a paneling effect, and those which conceal them. In the first class the joint may be butted and concealed with one or more V-channels, or the edges of the plywood sheets may be rabbeted to receive a flush molding, beaded, or otherwise ornamented. Plain butt joints also may be covered with simple battens, narrow moldings, or snap-on metal moldings. If the joints are left open to allow movement, the wallboard may be nailed directly to the studs.

Tight flush joints over furring strips provide overall flat surfaces suitable for painting or papering. The sheets can be butted at the edges, rabbeted to lap, or cut into V-edges fitting into V-channels. Joints also may be made open and then filled by driving in glued splines having slightly tapered edges, the splines being surfaced flush after drying. Splines of contrasting color make interesting inlaid bands when the plywood being installed is faced with figured hardwood veneers to be stained or given a natural finish.

POPULAR SCIENCE MONTHLY SHOP DATA

Air-Propeller Adapter for Your 13,000-r.p.m. Gas Engine



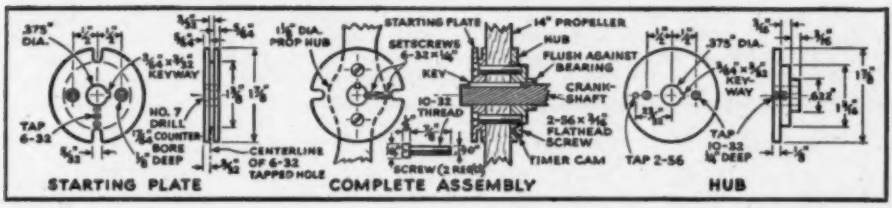
Left, a model ice sled, air driven by one of J. C. Magee's engines. Above, a gas tank for bench tests. The line is 3/32" copper tubing, soldered into one end. A coupling connects it to the needle valve.

ALTHOUGH there are several ways to fit an air propeller to the gas engine designed by J. C. Magee (see P.S.M., June, July, Aug., '46), the adapter shown here calls for no extra machine work on the crankshaft.

Be sure to use a good-quality 14" prop with a strong hub. If the hub is thicker than ½", make the 10-32 screws proportionately longer. The keyway in the propeller is for clearance only and can be filed in.

All parts but the screws are dural. Remove all burrs from the groove and the slots to prevent fraying of the starting cord. Use two 6-32 setscrews, the first entering a dimple in the crankshaft for positive drive, and the second tightened down to lock the first. If when installed the propeller comes too close to the timer arm to permit safe adjustment, bend the latter back.

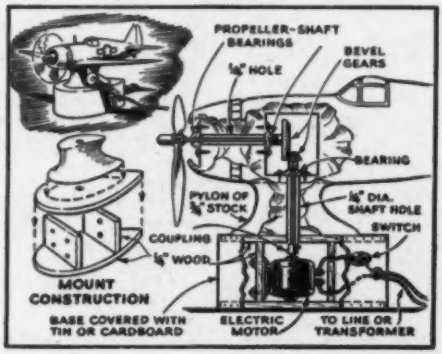
A good gas tank for bench tests is made from 1" brass tubing with a 1/32" wall. Two end disks of 1/32" brass are soldered in and a small oil cup is soldered on as a filler cap. This cap *must* allow air to enter the tank, or gas will not flow. With the tank full, the gas level must not be above the jet opening in the motor.



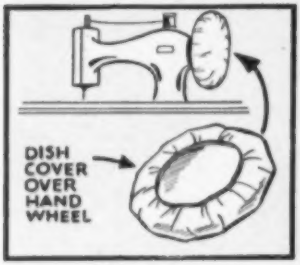
Electric Propeller Drive Adds Action to Scale-Model Plane

ANY solid scale model plane will make a more interesting display piece if the propeller revolves. The streamlined mount shown will house a small motor of either the 6-volt or the 115-volt type. A low-voltage motor can be powered from a toy transformer. Shafts, bearings, and bevel gears may be found in toy construction sets.

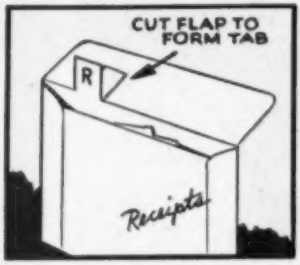
The fuselage must be hollowed out, and a removable panel may be set in to permit oiling. Carve the pylon of ¾" stock and cover the sides of the base with cardboard or tin plate, painted to suit.—F. MITCHELL.



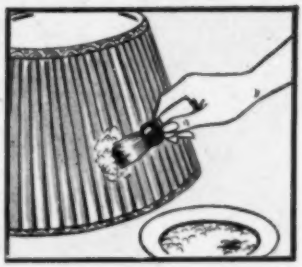
KEEPING THE HOME



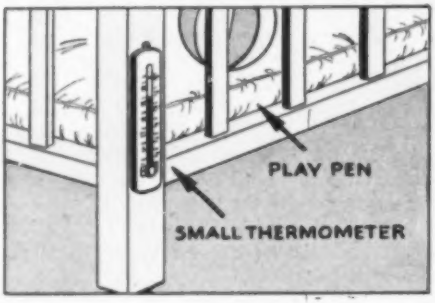
Guarding a sewing-machine wheel with an elastic-bound dish cover will keep children from putting fingers in the spinning spokes.



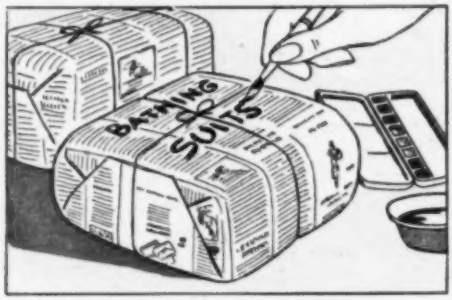
Ordinary envelopes can be used in a filing box when tabs are cut to identify contents. The tabs remain up when the flaps are closed.



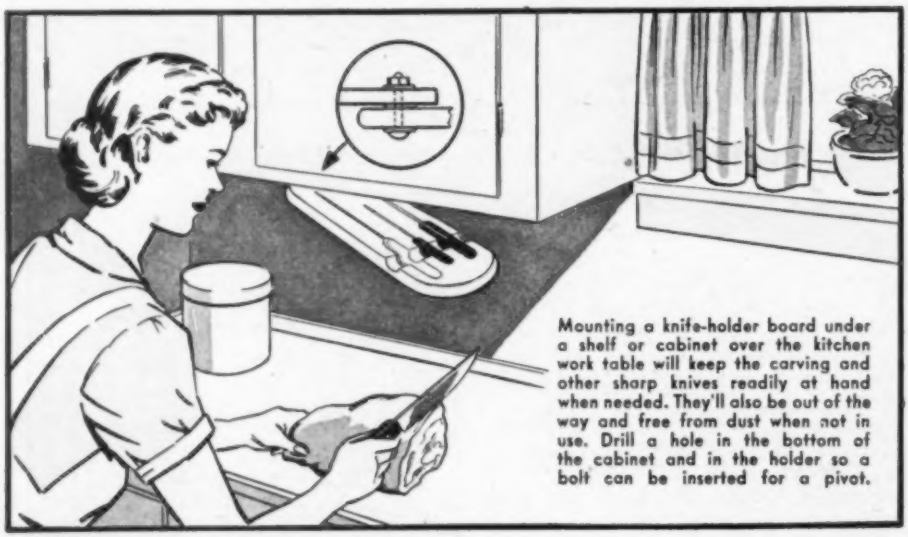
Fabric lamp shades may be cleaned with soap and water and a shaving brush in light, circular motions. Use the brush also for rinsing.



Since the floor is usually the coolest part of a heated room, a thermometer kept at one corner of the play pen will be a safeguard for a baby by eliminating guessing at the temperature.

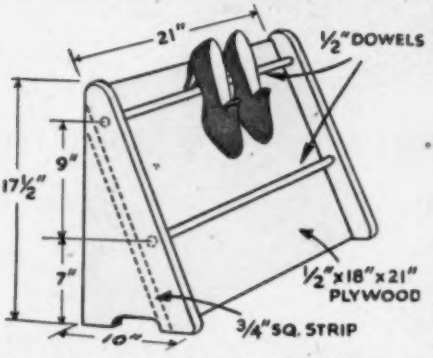


Articles stored for future use can be identified quickly if they are wrapped in newspaper and then marked with water colors or ink applied with a brush. Ink will wash out of a brush easily.

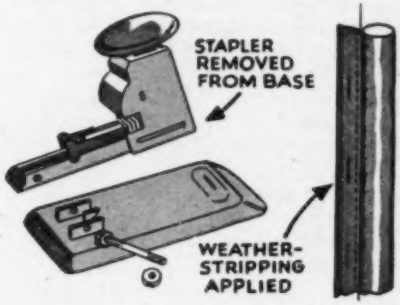


Mounting a knife-holder board under a shelf or cabinet over the kitchen work table will keep the carving and other sharp knives readily at hand when needed. They'll also be out of the way and free from dust when not in use. Drill a hole in the bottom of the cabinet and in the holder so a bolt can be inserted for a pivot.

SHIPSHAPE



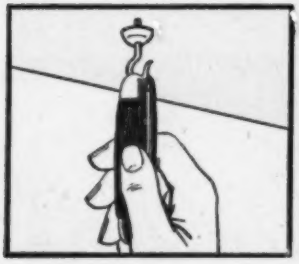
Two dowels mounted in a simple wood frame, as shown above, make a convenient rack for holding half a dozen pairs of women's shoes. Back the edges of the plywood with ¾" strips for a nailing surface. Enlarge the dimensions for a man's shoe rack.



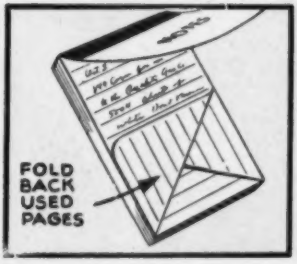
Stapling of felt or beaded fabric weatherstripping is far simpler than using a hammer and tacks, and a much neater and tighter job will result. Some staplers can be swung back from their base for such use; others may be removed by unbolting.

With an extension bolted on two legs, a stepladder can be used safely on a stairway for painting and washing the ceiling and walls. Usually moving up or down two steps at a time with such a ladder permits you to reach all surfaces.

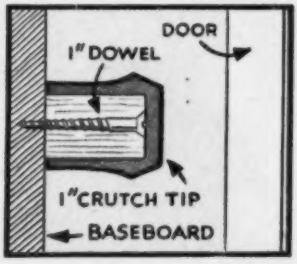
Small screw eyes, cup hooks, and L-shaped hooks can be screwed in easily with the slotted end of a pocketknife. Use drilled holes to avoid strain on the knife.

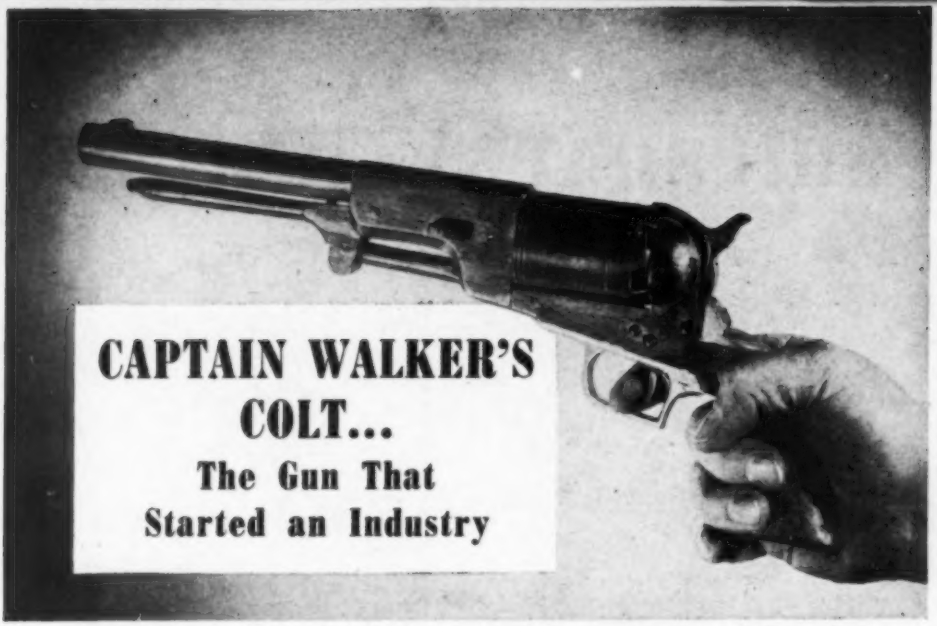


Fold over and crease alternate corners of notebook pages as you use them. This leaves a V-shaped notch before the next clean page and saves thumbing through.



A short length of dowel screwed to the baseboard near the hinged side of a door is excellent as a doorstop when covered, as below, with a rubber crutch tip.





CAPTAIN WALKER'S COLT...

The Gun That Started an Industry

By CARL G. ERICH

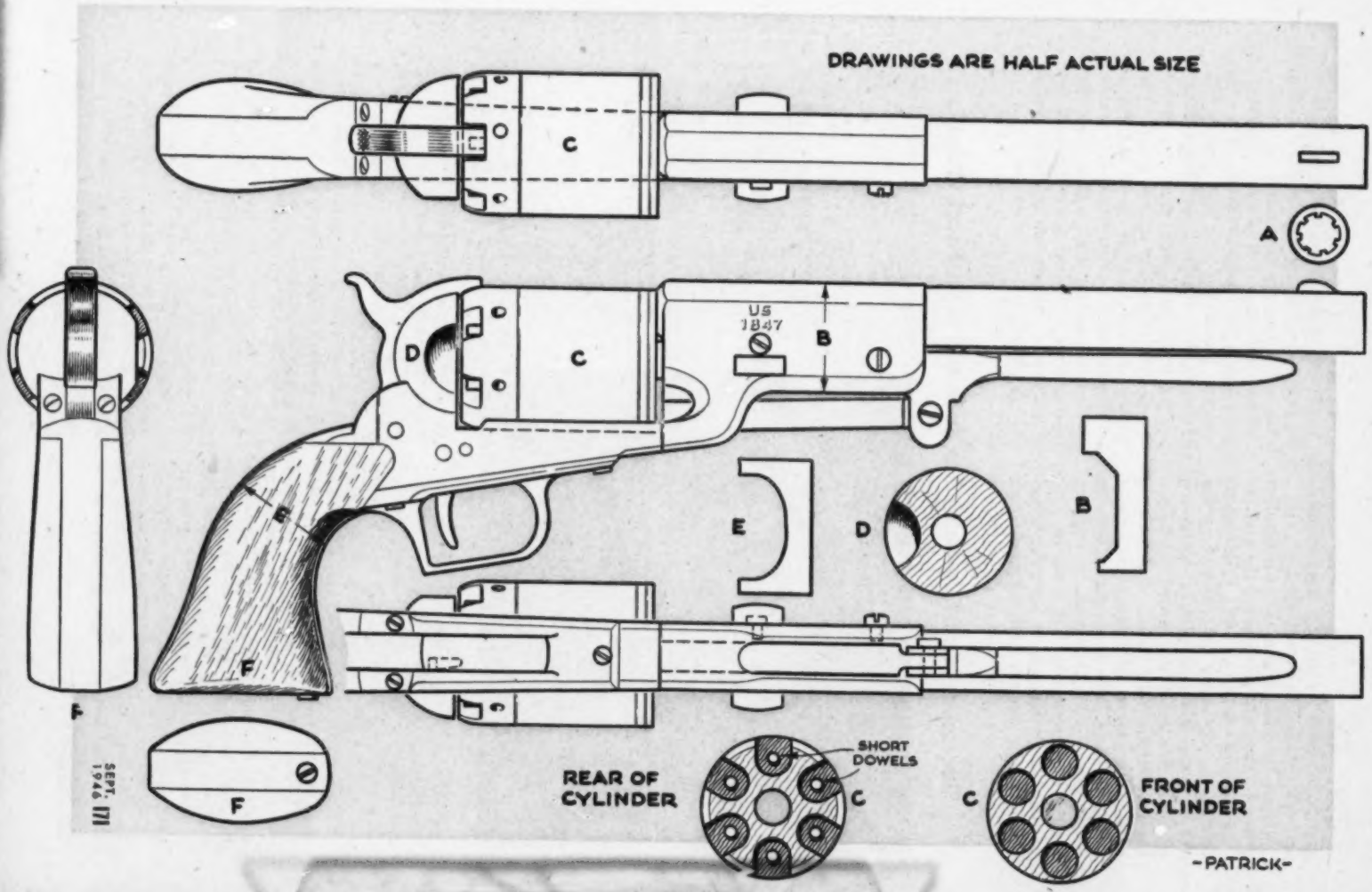
ALMOST everybody who knew anything about guns agreed that Sam Colt had invented a fine revolver. A Colt repeater, they said, was just about as good as five ordinary pistols. But then, who wanted five pistols?

One company that thought it knew the answer started a factory at Paterson, N. J., in 1836 to manufacture arms under Colt's patents. By 1842 it had drifted out of business, and Colt found himself the inventor of a famous failure.

Hardly had the supply of these new revolvers stopped, however, when the demand began to increase. Gen. Zachary Taylor, a veteran of the Seminole War, was sent to Texas in 1845 to establish the disputed border between the United States and Mexico. Many of Taylor's officers had already become familiar with Colts both in Florida and Texas, but when they tried to purchase them they discovered that only a handful were to be had.

Convinced of the merits of the Colt repeater, Taylor dispatched a former Texas Ranger, Captain Samuel H. Walker, of the U. S. Mounted Rifles, to Washington and New York to arrange for a new supply. But so thoroughly had Taylor's agents scoured the market, that Colt could not locate even a single sample from which to work. As a consequence, he and Walker redesigned the

So lifelike you almost expect it to fire, this model has fooled experts at close range. One of the photos shows the original gun, the other its wooden image. Can you tell which is which? The model is at the left.


DRAWINGS ARE HALF ACTUAL SIZE
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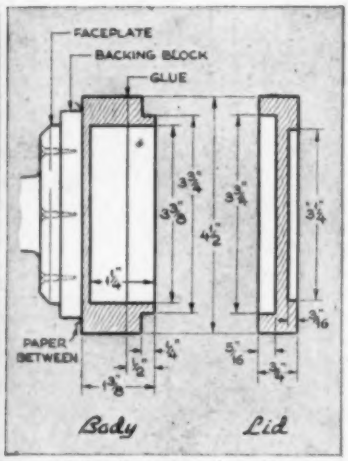
-PATRICK-

gun from memory, adding improvements and modifications as they worked.

Urged by Walker, the War Department ordered a thousand revolvers of the new design for early delivery. Since Colt had no factory, he conveyed his contract to Eli Whitney, son of the inventor of the cotton gin. The first order was turned out by the latter at Whitneyville, Conn., and the guns came to be known as Whitneyville Walker Colts. All special machinery reverted to the inventor at the completion of the contract, and, as orders continued to come in, Colt installed this machinery in a small plant in Hartford, the nucleus of his later factory.

Drawings of the model are all half size of the prototype; the gun may be made to this scale, or stepped up as desired. Trace the outlines onto a board of proper dimensions, and jigsaw a little outside the line. For convenience in carving, and in order to use thinner stock, make the cylinder separately, holding it in place with glue and screws driven from under the trigger guard. The wood is reduced to ½" thickness at the grip and finished on the edges to simulate a brass center band; walnut stock is then glued and bradded around it, and carved to the shape of the handle. All exposed screws consist of dowels, slotted and glued in place.

Recessed Top of Jewelry Box Is Inlaid with Pearl Chips



Any of the dimensions shown here can be altered to fit your own specifications.

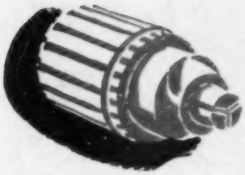
Borrowed from the goldfish bowl and set into the recessed lid of a jewel box, colorful and iridescent pearl chips brightly display their craft possibilities. Many similar uses can be found for these decorative stones.

Three disks of hardwood, all ¾" by 4½" diameter were used in this project. Glue two of them together to make the blank for the box, and glue this and the remaining single disk to scrap backing blocks. Center the lid piece in the lathe and turn out the inside to a depth of 5/16", leaving a ¾" lip.

Now mount the box blank in the lathe and turn a corresponding lip to make a tight fit in the cover. The lid can then be removed from its backing block and forced tightly on the box and a 3/16" recess turned in it. A piece of transparent plastic is fastened to the top with small brass escutcheon pins and rounded to match the wood. Remove the cover and finish the box, taking a light cut on the shoulder to give an easier fit to the lid.

Lift out the brass pins to remove the plastic, and draw or trace an appropriate design on the recessed portion of the cover. Lay out the pearl chips to fill in the pattern, lapping the pieces where necessary so that none of the wood is exposed. Cellulose cement will hold the stones without marring the design.

Finish the box in any suitable manner. Remove it from the backing block, and either finish the bottom to match the sides or glue on a circle of felt.—Elma Waltner.



FIX THAT DRILL CHUCK

IF IT'S JAMMED WITH CHIPS OR WON'T RUN TRUE, HERE'S HOW TO CURE IT

By J. C. Magee

JACOBS drill chucks, properly used, give many years of satisfactory service. It is occasionally necessary, however, to disassemble them in order to remove chips and dirt that have accumulated inside.

These drill chucks are held together by the press fit of the outer sleeve on the split nut that operates the jaws. Because of the force needed to press the sleeve off the split nut, the chuck must be properly supported in disassembling to prevent damage.

To disassemble the common types of Jacobs chucks, first remove the chuck from the drill-press spindle, using the wedge furnished, as shown in Fig. 1. Adjust the jaws to half capacity and mount the chuck, jaw end up, on a hardwood block that has been bored out large enough to allow the body of the chuck, but not the toothed sleeve, to pass through. Then, using a short piece of brass tubing that will straddle the jaws and bear against the chuck body, drive the chuck down through the outer sleeve with a hammer (Fig. 2) or an arbor press.

The split nut can then be taken out and the jaws removed. Should the jaws be burred from continued use, it may be necessary to tap them out with soft metal.

All the parts are next immersed in cleaning solvent or kerosene and thoroughly cleaned (Fig. 3). Remove any burrs from the edges of the jaws with a handstone as in Fig. 4, and clean them again.

Should the jaws or split nut be badly damaged, the chuck must be returned to the factory for repairs unless you have a toolpost grinder and wish to purchase the replacement parts and grind the jaws yourself.

To reassemble the chuck, insert the three jaws in the body in accordance with the numbers stamped on the end of each jaw and on the chuck body. Get the ends flush with each other and the threads in position to engage the split nut. Apply a good grade of grease to the threads of the split nut and assemble in the groove. Reverse the disassembling procedure and, with the jaws at half capacity, drive the body of the chuck into the sleeve, as shown in Fig. 5.

The sleeve should turn freely when as-

ROUTING AND MILLING, with their attendant side pressure and vibration, tend to pull a chuck off the spindle taper, with possibly dangerous results. Such chucks are designed only for drilling, in which working pressure keeps the tapers engaged. However, they can be used safely if anchored to the spindle with a screw.

Chuck a centerdrill, lower it between the V-jaws of a drill-press vise on the table, clamp it tight, and clamp the vise in place. Open the chuck, remove it, and lower the spindle against the drill in the vise to spot a hole on dead center. Then substitute a No. 7 drill and tap the resulting hole ¼"-20. Drill a 17/64" hole through the chuck body and use a ¼" bolt to secure it to the spindle. Don't forget to take it out when you next want to remove the chuck, though.—J.C.M.

1

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sembled. Try the key in the chuck. If it does not engage properly, the body has not been pressed far enough into the sleeve.

To determine how accurately a chuck runs, check the tapered spindle of the drill press first, using an indicator. If it runs considerably out of true, the taper must be recut carefully. Remember the actual run out is only half the total indicator reading.

Next, test the chuck on the spindle (Fig. 8), using a straight dowel pin and an indicator. If it runs out of true more than is desirable, or if a new split nut and new jaws are used, grinding will be necessary.

The most important part of this operation is mounting the drill chuck properly. Chucks with standard Morse taper arbors can be mounted directly in the lathe spindle. Those with internal threads, as on electric hand drills, must be mounted on a carefully threaded stub arbor against a true shoulder in the same manner as on the drill. Chucks with an internal taper, as for a bench drill press, require a tapered arbor. The mounting surfaces must be free of dirt and burrs.

Open the jaws to full capacity and place as far back in the chuck as possible a 1/16" thick washer of a diameter that will just go in. Then tighten the jaws so they exert pressure as they do in service.

Use a tapered mounted wheel of medium grit, as shown in Fig. 6. It should be carefully dressed to a 1/16" flat so that only the leading edge will grind. The carriage stop

5

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3

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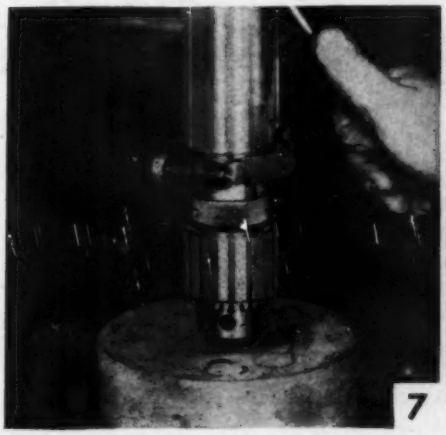
should be in position to prevent the grinding wheel from hitting the washer. Remove as little stock as possible—just enough to clean up all three jaws.

Take out the washer and check the run out in the lathe with the dowel pin and indicator. Remove the chuck from the lathe, disassemble it, and wash thoroughly to remove all traces of dust and grit. Then grind away the short shoulder left by the washer at the back of the jaws, clean them, and reassemble the chuck. Clean the chuck taper and spindle, open the jaws to full capacity so they will be inside the chuck, and press the spindle on, as in Fig. 7, using a block of wood and the drill-press hand-feed lever.

Figure 8 shows a large, ½" capacity chuck. The internal taper fits directly on the spindle taper of the drill press.

Ball-bearing chucks are disassembled by pressing the sleeve off over the jaw end of the body and removing the balls from the race through the slot. This leaves the nut free. To reassemble, insert the three jaws according to number, advance them part way, apply a good grease on the nut threads, and place the nut in position to engage the jaws. The balls are then fed into the race through the slot, grease is applied to them, and the sleeve is pressed on.

To remove a chuck from the threaded spindle of an electric drill, fit a pin into one of the key holes and tap firmly with a hammer. The thread is right hand.



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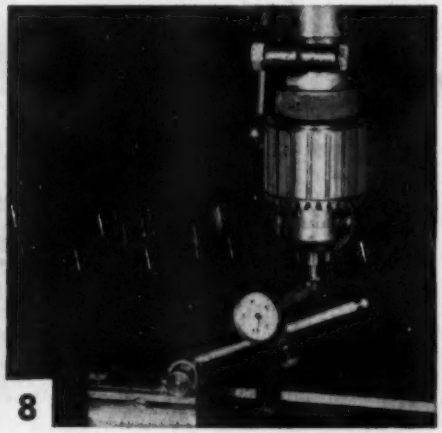


8

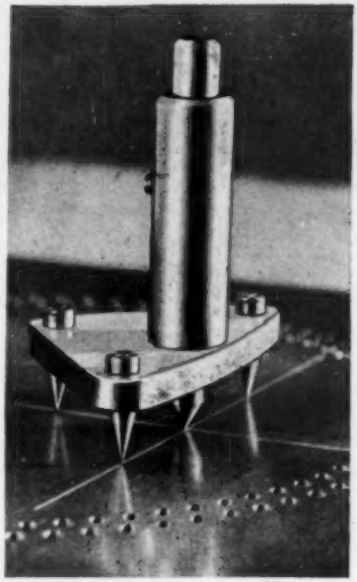
Centerpunch on Tripod Base Marks Intersection of Scribed Lines

EXTREMELY accurate layout work is done speedily with a centerpunch designed to locate the exact point of intersection of right-angle lines. The two front pins are slid along one line until the rear pin drops into the other. This puts the punch directly over the intersection. A light hammer tap then gives an accurate punch mark that can be indicated true in the lathe for drilling and boring.

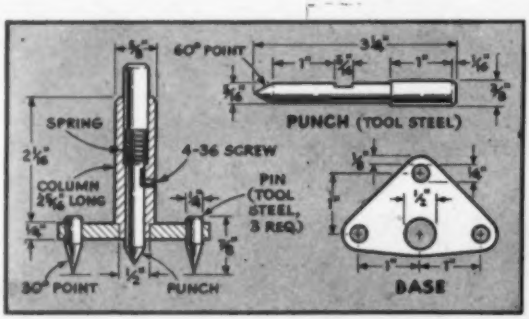
Care must be taken when driving in the pins to make the centerpunch stand precisely at right angles to the surface of the work. The slightest tilt will cause inaccuracy.

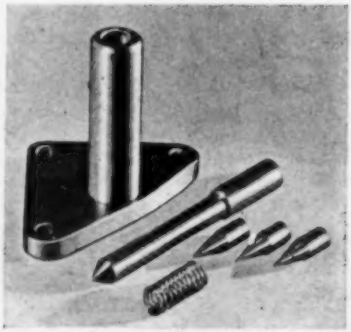
Lay out the base accurately and drill for the three legs and the centerpunch column. This is drilled and reamed to ⅜" for 1" of its length and to 5/16" for the remainder, and the lower end is turned to a drive fit in the base. Then the column and base are pressed together and rotated in the lathe chuck against an indicator to see that they are at right angles.

The punch is tool steel hardened and ground for a sliding fit in the column hole. A light spring made up from piano wire keeps it off the work, and a retaining screw holds it in the column. The three locating pins are also tool steel, hardened and carefully ground for a press fit in the ¼" dia. holes in the cold-rolled steel base.—C. W. WOODSON.



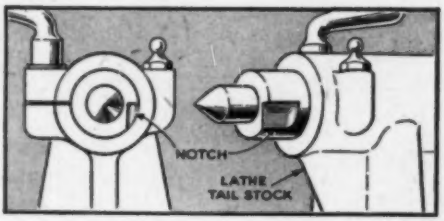
When the two forward pins are slid along one line and the third falls into a line scribed at right angles, the centerpunch is directly above the intersection. The base and column, centerpunch, spring, and three pointed legs are shown below.





Notched Tailstock Barrel Helps Set Tool at Center Height

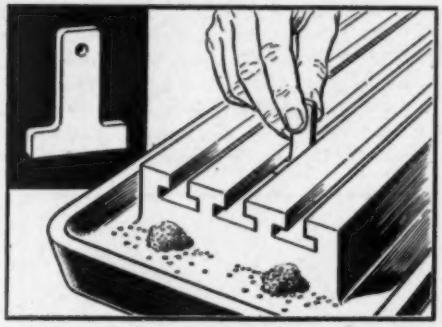
You can set lathe tools at exact center height if the tailstock barrel is notched on a level with the dead center, as shown at right. The tool is simply run up to the tailstock, set to touch the top of the notch, and tightened. Mark the barrel by scribing it with a sharp-pointed tool set to center height. Be sure the tailstock is tightened and the barrel clamp locked when this is done. Then mill or file the notch.—EMIL GAYNOR.



NEW SHOP IDEAS

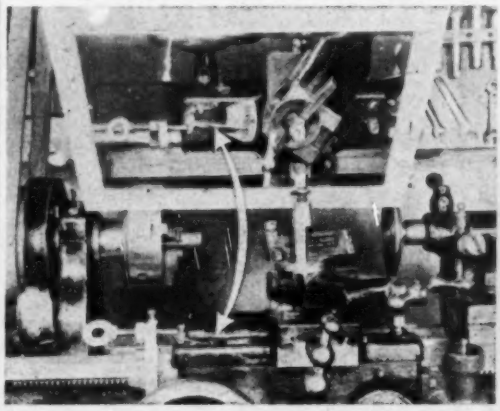
IDENTIFICATION MARKS on small parts are easily put on with an automatic prick punch—one with an internal spring-trigger mechanism that acts as the hammer. The removable point can be engraved or otherwise formed, or an entire set of points may be made with different markings. An inspector in a large electrical-equipment plant uses such a punch for a stamp to avoid carrying a hammer.—J. C. MAGEE.

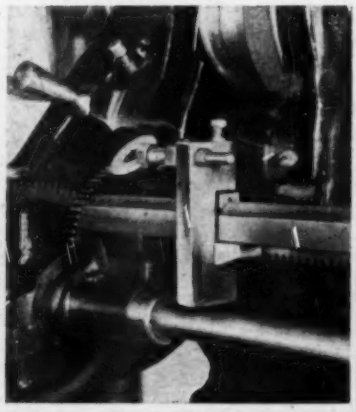
CHIPS ARE CLEANED out of the T-slots in a machine table with a T-shaped piece cut to a free sliding fit from flat scrap. A hole in the end permits hanging it conveniently near the machine.—EDWARD J. FRONCZEK.



DEPTH OF BORE can be regulated with considerable precision by use of the attachment shown below. In the photo at left, a mirror shows the indicator arm from above. Use a ⅜"-16 screw as a stop in a bracket attached to the lathe ways with a setscrew, as shown in the photo at right. A full turn will give a 1/16" adjustment, a half turn one of 1/32", and a quarter turn an adjustment of just 1/64".

This screw can be set simply to stop the carriage, but an additional refinement is the spring indicator—a pivoted right-angle lever affixed to the carriage to make contact with the stop screw. The scale is graduated in 64ths, and is particularly useful for boring recesses or turning narrow shoulders.—DONALD R. DOREMUS.

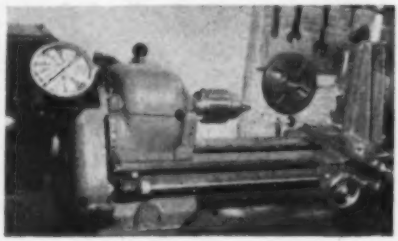


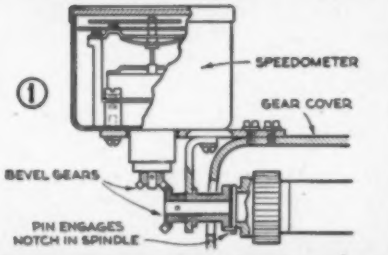


Clever Uses for Old Dashboard Gauges

ANNOUNCING THE WINNERS OF THE CONTEST FOR NEW WAYS TO USE OLD AUTO INSTRUMENTS. YOU'LL FIND IDEAS YOU'LL WANT TO TRY.

A HIGH order of craftsmanship and ingenuity marked the entries in POPULAR SCIENCE MONTHLY'S recently concluded dashboard-gauge contest. Saved or plucked from wrecking-yard bins were many a weary old speedometer or oil-pressure gauge to blossom forth, refurbished, as instruments designed to fill readers' needs. Here's a description of some of the prize-winning entries.



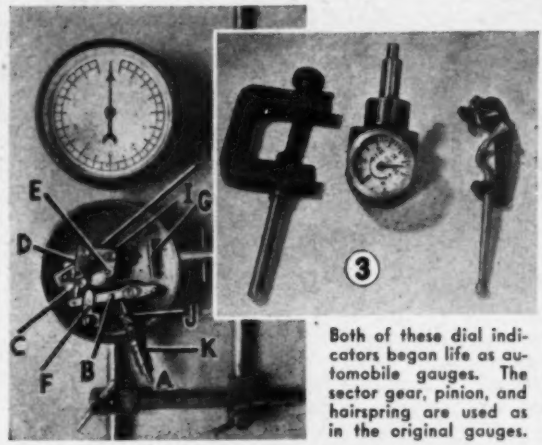


First prize went to Fred N. Schwend, of Los Angeles, who built the lathe surface-speed indicator pictured at the left. As machinists know, cutting metal at the correct speed is important since too much speed causes chatter and burns the tool, while too little speed wastes time and gives a rough cut. Getting the right speed isn't just a matter of selecting the right r.p.m.'s; surface speed is of course affected by work diameter and varies with it as well as with the spindle speed.

Mr. Schwend mounted a speedometer on the gear cover of his lathe, using a pair of bevel gears to transmit motion. A pin in a flange engages a notch in the end of the spindle for a positive drive. This arrangement permits the instrument and gear cover to be swung back readily when a collet chuck is used or work is to be inserted through the spindle. Readings are taken from a new dial of heavy white paper, calibrated in seven concentric circles for seven diameters of work on this 6″ lathe.

An entirely different problem was ingeniously solved by Dr. G. W. Salsman, of La Junta, Colo., winner of the second prize. Dr. Salsman's quarters are laid out so that his secretary's desk is 65′ from his own office, a distance that made efficient office management a bit difficult. His answer was to obtain an electric fuel-tank gauge (see P.S.M., March '46, p. 138), a tank unit to match, and a doorbell transformer. Hooking them up in a series circuit, he put the resistance unit within his secretary's reach with a radio knob and pointer attached so that she could vary the resistance at will by turning the knob. In his own office Dr. Salsman placed the one-time fuel gauge.

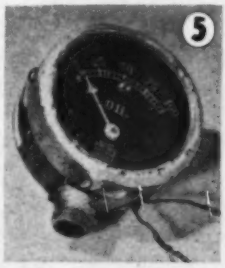
With this indicator the secretary can give



Both of these dial indicators began life as automobile gauges. The sector gear, pinion, and hairspring are used as in the original gauges.

a continuous report on how many patients are waiting, simply by advancing the knob a trifle whenever a person enters the reception room. As the doctor say: "This enables me to use more time when I have it, and to hurry when necessary."

Two dial indicators made from scrap auto parts tied for third prize. The one at the left above, built by Carlos Raynsford, of New York City, started out in life as an oil-pressure gauge but has been reincarnated as a machinist's indicator that is accurate to .0005". Mr. Raynsford removed the original Bourdon tube and substituted a motion-multiplying lever that actuates the gear segment and pinion. A similar technique was used by Elwood Morris, Columbus, Ohio, except that he started with an engine-temperature gauge, pictured at the right above with its mounting clamp and hole attachment. He reports that his device has repaid him amply by simplifying the task of setting up work on the lathe, miller, and shaper.



A tire-pressure gauge made of an oil gauge was the contribution of Benjamin B. Tassmer, Jr., of Wallingford, Conn. To make a fitting that would receive a valve stem, he took an oil-line elbow, counterbored one side for the stem, drilled a 1/16" hole right through, and soldered in a short piece of 1/16" rod to engage the valve. A washer, tubing, and some hydraulic-line fittings completed the device (Fig. 4).

A special gauge solved a special problem for Walter F. Lovell, of Quincy, Mass. His difficulty was a sporadic, unpredictable failure of water pressure in the main supplying his home. After having been left in the lurch at the faucet on several occasions, Mr. Lovell noted that interrupted service was always preceded by gradually falling pressure. He took apart an old oil-pressure gauge (Fig. 5) and inserted in it two electrical contacts that touched only when pressure dropped to 12 lb. or less. Wired in series with a buzzer, dry cell, and switch, this provided a low-pressure signal that enabled Mr. Lovell to draw sufficient water for his needs before the supply failed entirely. This "water alarm" has been in service for 15 years, serving as a Paul Revere to warn Mr. Lovell and his neighbors of impending drought.

Accurate tuning of an auto engine is easier with a vacuum gauge in the intake

manifold, so L. W. Edgerton, of Windsor, Conn., made his own for the purpose. Taking a discarded Bourdon-tube pressure gauge, he converted it to a vacuum gauge simply by bending the tube outward until the pointer was at the extreme right of the dial when at rest. With a length of tubing hooked into the windshield-wiper line, he now has an instrument that permits him to adjust a dual carburetor right on the nose.

Another winner is Keith Rumsey, of Friendship, N. Y., who built a remote-reading anemometer from a salvaged speedometer. A spinning vane above his ridgepole turns a shaft that runs down through the attic to a bedroom wall, where the speedometer is mounted. He writes that the instrument has reported wind velocities as high as 62 m.p.h.

How to Service-Check Your Oil Burner

By HAROLD P. STRAND

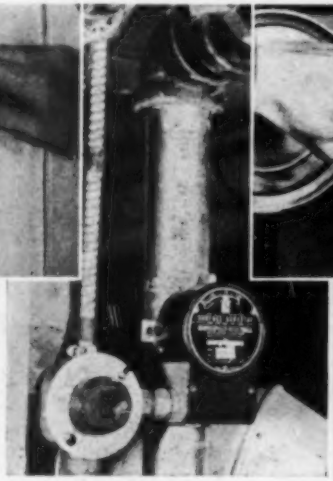
EVEN though the owner of an oil burner will usually want to call in a regular service man to handle major troubles, there are real advantages to understanding a burner and its controls. This knowledge will permit the owner to make his own minor repairs and adjustments, and will be particularly handy on a cold winter day when an interruption of service occurs that can be remedied by "know-how" and five minutes of work.

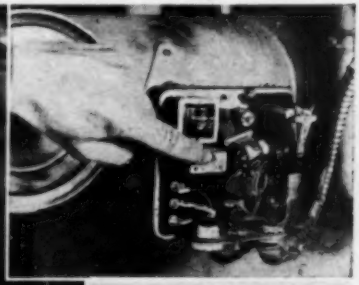
An oil-burner installation requires at least three controls: a thermostat, a combination stack switch and relay, and a high-limit control. There is a wide variety of special controls, and many different types and makes of equipment are in general use. For reasons of simplicity we will examine here a gun-type burner having just the three basic controls. With some modifications, the same procedures can be applied to other burners.

The operating cycle of the burner is as follows: When the thermostat "calls for heat" by closing its contacts, a low voltage is applied to the relay in the stack unit, snapping its contacts closed. This supplies 115-volt current to the ignition coil and the motor. Ignition takes place and the burner begins operation.

In back of the stack unit, projecting into the smoke pipe, a bimetal heat-sensitive element is located. It reacts to temperature changes within the stack either by sliding or twisting a shaft that opens or closes contacts within the stack unit. In the unit shown in the picture directly below, heat causes the shaft to turn to the right, operating a mercury switch and two other sets of contacts located behind and below it. Two of these, open at the start of the cycle, are known as the "hot" contacts; the others, closed at the start, are the "cold" contacts. A final component is a safety switch with a thermal element that will pass current

The thermostat, one of the three basic controls used on virtually all automatic oil burners, requires little attention. Remove the cover and blow out any dust. If the points are dirty, gently clean with fine sandpaper.





At left, a high-limit control on a furnace delivery pipe stops the burner at a preset maximum temperature. Above is a stack switch and relay; the finger points to the reset button. This unit guards operation.

for only a measured length of time before it opens.

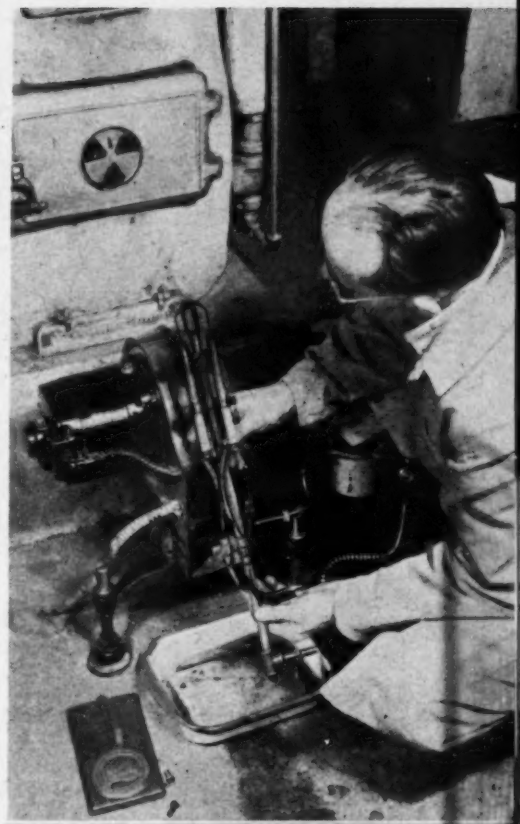
To resume with the operating cycle: the burner flame produces heat in the stack, causing the bimetallic unit to turn to the right. The hot contacts close, making a shunt across the safety switch and allowing the burner to continue in operation. Meanwhile the cold contacts open, breaking the starting circuit, and the mercury switch is tilted to the right, opening the ignition circuit, which is not needed for continued operation in the burner described. Certain other burners employ continuous ignition and have a slightly different stack control.

If the oil fails to ignite, due either to fuel or ignition failure, there is no heat in the stack to actuate its bimetallic element. Since the hot contacts then remain open, they cannot shunt the safety switch, and after a short time this trips open. The burner cannot now be returned to operation or attempted operation until the manual reset button is pressed.

Suppose again that the burner is in normal operation and runs out of fuel. As the stack temperature drops, the hot contacts will open; and since the cold contacts are already open, no circuit exists through the relay coil and this stops the motor. After about one minute the cold contacts and the mercury switch will reach starting position and the burner will attempt to start. If the fuel stoppage continues the safety switch will cut off this attempt to start; if the fuel supply is restored, the burner will operate normally.

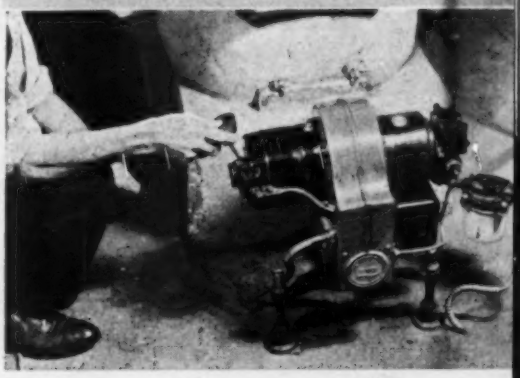
Finally, suppose that, because of a high thermostat setting in cold weather, the thermostat is still calling for heat at a time when the burner has built up water temperature or steam pressure to the upper safe limit. The high-limit switch then intervenes to cut off the burner, regardless of thermostat demand, until the temperature or pressure drops. In a steam-heating system this unit may be either a pressure-sensitive (diaphragm) type or a temperature-sensitive one; in a hot-water or hot-air system, the latter kind is used.

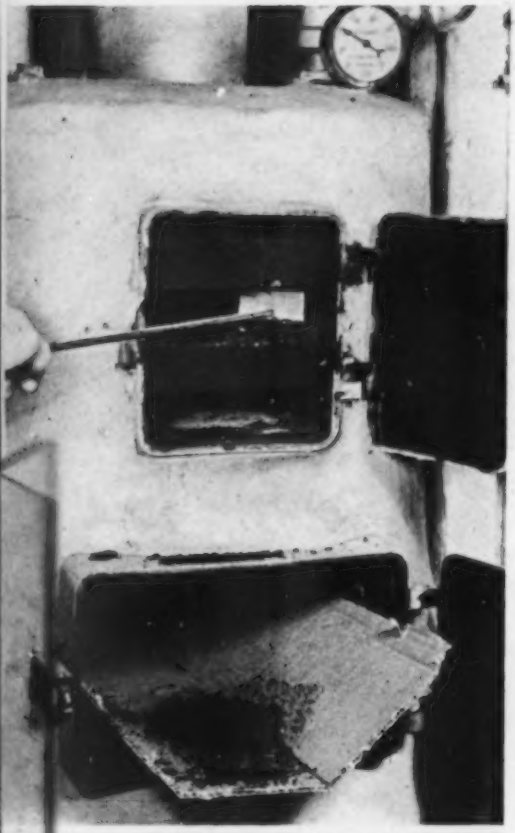
Start your annual oil-burner service-check by cleaning out the inside of the boiler and stack. Place a piece of cardboard in the firebox and scrape out all deposits from around the boiler sections. A stiff wire brush on a long handle will be useful. Even better, if you have one, is an old vacuum cleaner with a hose attachment. This can also be used to clean the stack. *[Turn the page.]*



Inspection of the electrodes, high-tension cable, and the nozzle is accomplished by withdrawing the entire unit from the air tube, as pictured above.

Add several drops of medium motor oil to each oil cup every two months of operation. This is a gun type burner, found in many domestic installations.





Removal of soot and other residue from the inside of the heater and stack should be done every fall. An old vacuum cleaner makes this dirty job easier.

An oil patch on the floor like this, slowly growing larger, may mean a loose union or a defective fuel line. Here the leak was in the tube under the floor.

Don't be tempted to cut short this job simply because it is a dirty task; the accumulated soot can cause extra fuel consumption and retarded delivery of heat.

The next step is to check the firebox for broken or loose firebrick or cement. Breaks in the firewall may allow the flame to get through to the boiler base, burning a hole through it or otherwise causing damage. After replacing any defective brickwork, clean out the firebox with the brush or vacuum cleaner.

As a general rule, the control units of an automatic heating system need little attention. Remove the cover of the thermostat and blow out any dust and lint. Inspect the contacts; if they are clean, simply draw a strip of paper between to remove any tiny dust particles. If they appear dirty or pitted, gently draw a piece of fine sandpaper between them. Do not disturb the adjustments if regulation has been satisfactory; if not, either call in a trained service man or write the manufacturer for instructions before changing the settings.

In most cases the stack-switch unit also will need little attention, although it is a good plan to blow out any dust and to clean the contacts gently. The adjustments that govern the timing and control of the operating cycle are usually made at the factory or during installation, and they will as a rule remain correct indefinitely. Use no oil in any circumstance in either the thermostat or stack unit. The high-limit switch calls for no attention unless damaged or worn out.

Apply a few drops of medium motor oil to the lubricating cups of the motor, and repeat this about every two months of operation. Do not add too much oil, since it might injure the windings of the motor or the centrifugal starting switch.

After the tank has been filled, check along the line for fuel leaks. Wet or dripping unions or valves should be tightened or replaced. If a slowly spreading oil patch appears on the cement floor under which the copper fuel line runs, first check the nearest couplings for tightness. If they are snug and the oil stain spreads, it will probably be necessary to break into the cement over the supply line, solder or replace the tubing, and re-cement the floor.

In a thorough servicing job, the internal parts of the burner should be withdrawn from the air tube for inspection and cleaning. Shut off the oil supply, open the main switch, and disconnect the oil line at the

side of the burner. Remove the back cover on the burner and, reaching inside, pull the high-voltage cables free from their sockets in the side of the transformer. The entire unit can then be removed, as shown on page 181.

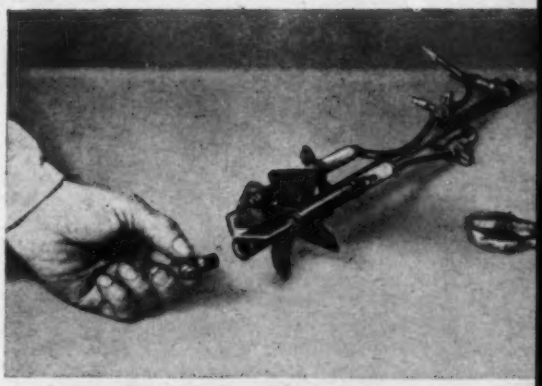
After wiping the parts clean, examine for broken or cracked porcelain insulators and for imperfect cable insulation. The electrodes at the end should be spaced ⅛" to 3/16" apart, and should be located just out of the direct vapor spray from the nozzle.

The nozzle itself can be removed with two wrenches and the strainer behind it cleaned of its gummy sludge. Many nozzles can be separated by unscrewing so that the stem, tip, and whirl chamber are exposed for cleaning and inspection. Use great care in handling the nozzle, since the machining is precise and the careless use of tools can irreparably damage the tiny oil channels. Clean the parts with a soft brush and fresh kerosene, wipe dry, and examine under a magnifying glass for signs of wear or roughness. See that the orifice in the end is open, but use only a piece of very fine brass wire to clean it. The smoothness of the internal surface and the concentricity of the assembled parts determine the quality of the flame and the rate of fuel consumption.

After replacing the parts in the burner, turn on the oil, close the line switch, and let the burner start. When the flame has reached a stable form, make sure it fans out and carries back normally. The fuel should burn completely, with a clean, hot flame. A smoky fire may indicate a dirty or defective nozzle or an insufficient air supply. It may also mean that an excessive amount of oil is being delivered to the nozzle, more than can be properly vaporized and burned.

Usually, careful adjustment of oil pressure and air supply will produce a satisfactory flame. The method of oil-pressure adjustment varies with different types of burners; if the information is not placarded on the burner, write to the manufacturer. The air supply is adjusted by moving the sliding cover in the blower housing.

As a rule the high-voltage transformer will cause little trouble, though it can burn out or become partially shorted and produce poor ignition. If careful checking of the wiring and controls point to the transformer as a probable source of difficulty, remove it to the bench for testing. Connect the 115-volt A.C. line to the primary and provide a suitable gap for the secondary voltage to jump, using high-tension cable. Use extreme caution against shock.

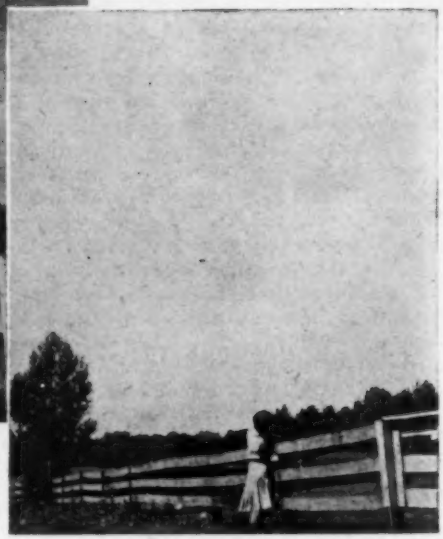


The nozzle may be unscrewed and any gummy deposit on the strainer behind cleaned off. Take pains not to damage the tiny oil channels in the nozzle.

The transformer should deliver a flaming arc ½" long or more. A thin blue spark or no spark at all indicates the transformer should be replaced. Another test, if a wattmeter and ammeter are available, is to connect these instruments in the primary circuit and compare readings with those taken from a similar transformer known to be in good condition. Unless the secondary is center-tapped, there should be no circuit to the ground or case; if a series test shows that one exists, the transformer is shorted.

If the burner persistently gives trouble, the pump and regulating valve may be taken apart, washed in kerosene, and checked over for any defective parts.

FILTERS... Magic Eyes of Photography



Dramatic cloud effects are produced by a red filter which absorbs blue light from the sky and renders it dark in contrast to clouds. At right, same scene taken without a filter has a blank sky.

HOW AND WHEN TO USE FILTERS OVER YOUR CAMERA LENS FOR NATURAL BLACK-AND-WHITE REPRODUCTION OF COLORS

By Kenneth S. Johnson

KNOWLEDGEABLE photographers would no more leave filters out of their shooting kit than they would omit film. Filters produce dramatic cloud effects in what otherwise might be a blank space above a landscape; they help make flowers more true to nature; they bring out beautiful grain patterns in photographs of fine furniture; and they are indispensable in making first-class copies of stained and faded prints.

How can disks of colored glass or gelatin perform these and other useful feats? An understanding of the magic behind those auxiliary photographic eyes can be invaluable to any photographer who would employ them for maximum effectiveness.

Light commonly called white actually is a mixture of light of all the colors of the rainbow. When a beam of white sunlight falls upon a prism, it is broken up and emerges as a series of beams of colored light. By convention these colors are known as red, orange, yellow, green, blue, and violet, although actually the number of colors in the visible spectrum is almost unlimited.

As photographers we are mainly concerned with the three primary colors of light—blue, green, and red (not to be confused with the primary pigments, which are blue, yellow, and red). When the three

primary colors of light are combined in approximately equal proportions, white light is produced. By mixing varying proportions, other colors can be obtained.

Films vary in their reaction to different colors. Orthochromatic film is sensitive to all colors except red. Panchromatic is sensitive to all visible colors including red. None can match exactly, in monochrome (black-and-white) tones, the relative visual brightness effect that colors have on the eye. All films are most sensitive to blue light, with the result that when no filter is used, blue areas are dark on the negative and tend to reproduce in tones lighter than normal.

No object has color in the absence of light. Its color depends upon the primary colors it absorbs or reflects when white light falls on it. A white house reflects approximately equal parts of the white light. Blue awnings absorb the red and green portions of light, leaving only the blue to be reflected toward the eye or camera lens. Red bricks reflect the red component of light while absorbing blue and green.

The color of a filter depends upon the primary colors it absorbs and those it transmits. Filters obtain their color from white light in the same way that other objects do, but being transparent they transmit, rather than reflect, the light they do not absorb. A red filter transmits red light and excludes blue and green, a green filter transmits green light, and a blue transmits blue.

The most common type of filter is medium yellow in color. It absorbs some, but not all, of the primary blue while freely transmitting green and red light.

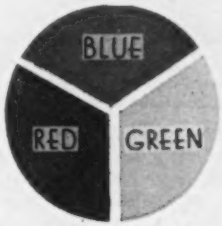
Filters always subtract something from the light. When a red filter is used, blue and green objects receive little or no exposure and consequently appear darker when the print is made. Red objects appear lighter on the same print. And so with other filters. Thus the tone of the object can be controlled by the filter—the object can be reproduced lighter by use of a filter that transmits its color, darker by one that absorbs its color.

How then can a familiar object, such as the American flag, be reproduced most satisfactorily? By making a test panchromatic exposure and print without a filter, you will probably find that there is not sufficient difference of tone between the blue field and white stripes, because of the high blue sensitivity of the film. This can be corrected by use of a filter that absorbs blue, but in addition to darkening the blue, it must not

WHAT FILTERS DO

NO FILTER

This photo of a color chart was taken with panchromatic film without a filter over the camera lens. The blue sector is recorded lighter than normal on the print.



YELLOW FILTER

Here blue is darkened and of nearer the density of red and green. A yellow filter gives approximately normal color rendition with panchromatic film.

BLUE FILTER

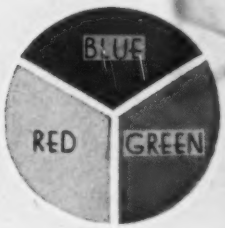
Both red and green light are absorbed, and these two colors appear even darker than normal on the print. Blue is transmitted freely and is overexposed.

GREEN FILTER

This lightens green tones by allowing green light to pass through, but red and blue are excluded. Thus underexposed, they appear darker on the print.

RED FILTER

When the exposure is made through a red filter, this is the result. Red light passes freely, and red is lightened, while blues and greens are darkened.



Stains marring some favorite print can often be eliminated by copying the photo through a filter of the same color as the stain. Here is a picture marked by a deep red stain.

And here is the copy with no stain apparent. Faded photos are similarly copied. Their tones are yellowed, and the filter must block out yellow so they print dark again.

noticeably affect the tone of the red stripes.

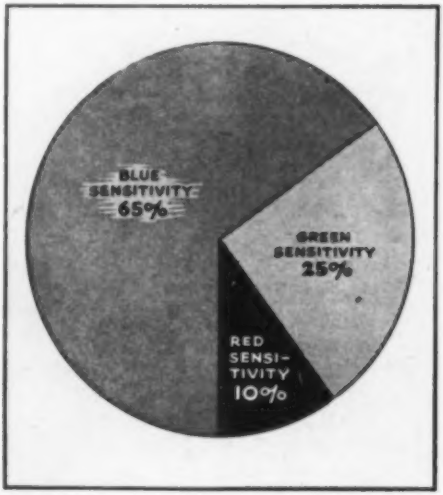
Yellow, green, and red filters all absorb blue light, but a red filter also freely transmits red light and would overexpose the red stripes. A green filter would render the blue field darker, but since it also absorbs red light, it would probably make the red stripes too dark. That leaves yellow. A filter of medium or dark yellow absorbs much of the blue light while exerting little effect on the red, and it should produce a print that appears natural in black and white.

Most faded photographs appear yellow. If you wish to obtain a copy negative of the best possible contrast and printing quality, use a filter that will reproduce yellow in the darkest possible tone. Since the yellow light reflected is actually a combination of red and green, a deep-blue filter, which absorbs red and green, should be used.

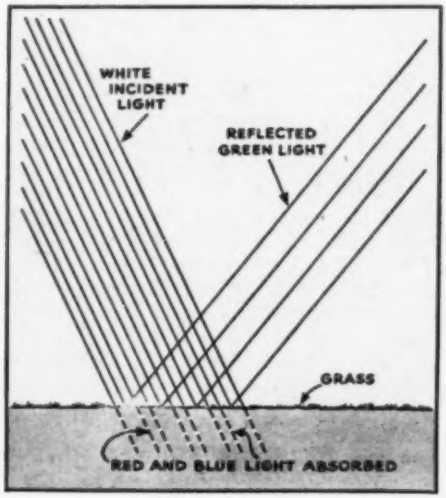
The same line of reasoning dictates the use of a deep-red filter to define clearly the grain pattern in a mahogany table. Such a filter would transmit and lighten the over-all red tone and emphasize the black grain.

Because of the large amount of blue light reflected by sky, in unfiltered pictures the sky is normally overexposed and blank. Approximately natural sky tones can be obtained through a medium-yellow filter, which holds back the blue enough to let the sky print as a light gray. Green and orange filters give progressively darker tones. Deep-red filters permit highly dramatic effects, with white clouds appearing as fluffy pieces of cotton in an almost black sky.

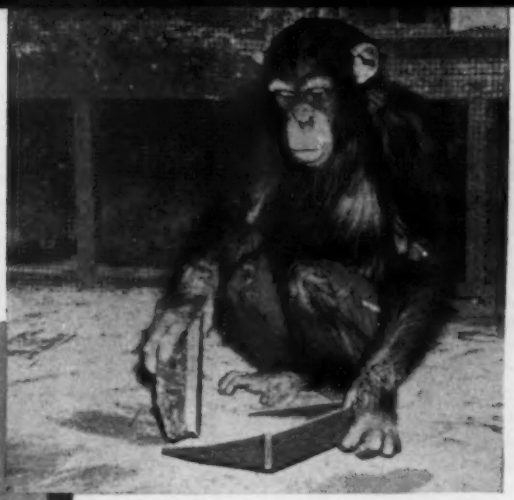
Red filters cut sensitivity 90 percent. Exposure must be 10 times longer, or more than three stops.



Grass looks green because it absorbs the red and blue components of light and reflects the green.



MONKEY BUSINESS with a CAMERA



Don't let that businesslike look fool you—Percy the chimp refused to sweep. But he would pose.

Good animal pictures are always popular. These were made with a Speed Graphic and flash gun.

PERCY the chimp lasted only a short while at his job of third assistant janitor at the Philadelphia Zoo. But it was long enough for staff photographer Isabelle Kauffeld to catch some ever-popular animal photographs. Using a Speed Graphic with synchronized flash as the only illumination, she posed the cooperative Percy with the help of a keeper.

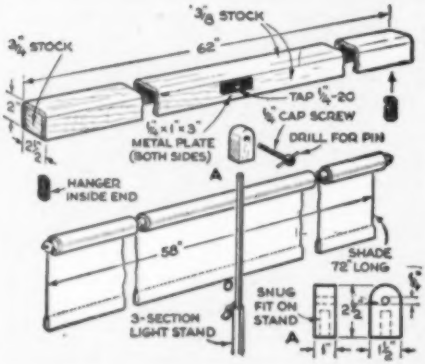
For good zoo pictures Mrs. Kauffeld urges quick shooting—animals have little patience and will not hold a pose long. And in the case of chimpanzees, who love to take things apart—keep a tight grip on the camera.

Posing for the floor-scrubbing picture was fun to Percy. He liked splashing water over the floor.

Percy learned the window washing routine quickly, but attendants had to mop up after him.

PHOTO IDEAS and EQUIPMENT

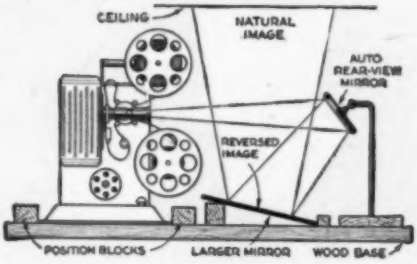
PLAIN BACKGROUNDS usually are best for portraits, as most amateur photographers know. Ordinary window shades, light colored on one side and dark green on the other, can be obtained in widths of 58" and lengths of 72". With very little work, a shade of this size can be converted into a practical background, portable and quickly set up, conveniently stored, and offering a choice of either a light or dark background. The drawing below shows one way a shade can be mounted.—FRANK MCCARTHY.



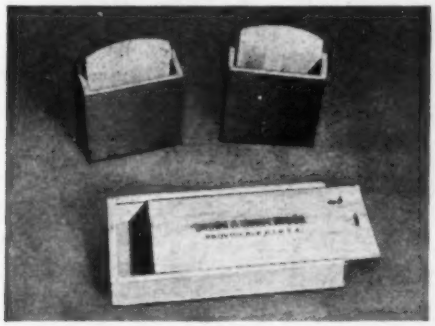
BULK COTTON can be protected from dust and chemicals by storing in a glass tobacco jar. Instead of keeping a large roll in one spot in the darkroom, store the cotton in several jars and place them where you do your retouching, reducing, negative swabbing, and ferrotype-tin cleaning.—T. L. B.

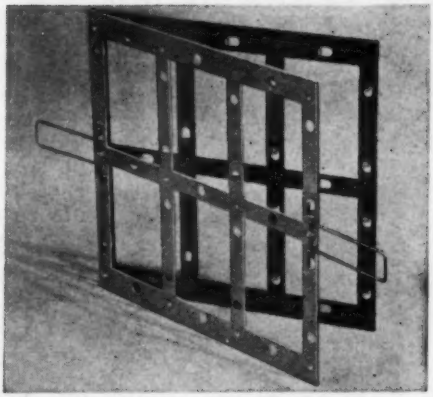
MY CARRYING CASE is so partitioned that I can remove any item of equipment without disturbing the rest. A simple box constructed of ¼" plywood, it was built after several commercial cases had been found inadequate for the accessories I need. One section contains the camera with ground-glass back attached, another the roll-film adapter, a third the exposure meter, lens tissue, and two rolls of film, and the fourth cut film holders and film pack adapter. An envelope containing reference booklets is tacked inside the cover.—D. J. B.

HOME MOVIES make ideal entertainment for invalids and bedridden persons, but it usually is difficult to project the image so the patient can see it without strain. A simple solution is to place the projector base between position blocks on a board, as illustrated below, and mount two mirrors as shown to reflect the picture on the ceiling. Once adjustments are completed, the mirrors can be fastened securely in place and the projector merely fitted between the blocks for each new showing. Obtain plate-glass mirrors if possible.—R. J. PAYANT.



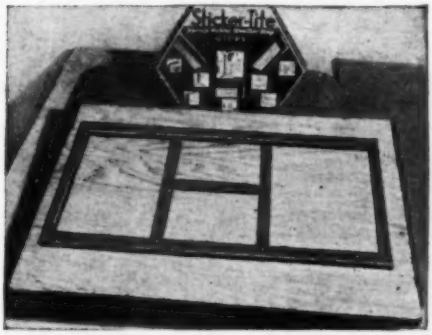
WHILE PRINTING I file my negatives in a "stop-and-go" system in the two small boxes below. At the start I place all negatives in a box that is painted green, meaning "go." When I finish with a negative, I place it in the second box, painted red. The boxes were made by gluing the cover shut on a micrometer box and sawing it in two.—G. T. L.

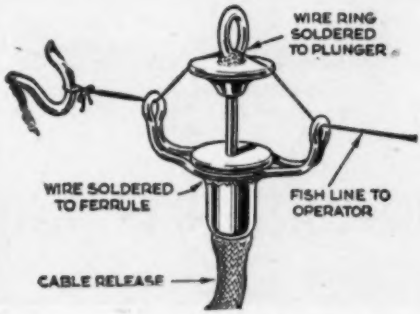




A RACK for simultaneous tray development of as many as six cut films is being distributed by C. & S. Products, Inc., of Cleveland, Ohio. As indicated by the above photograph, the films are clamped between the two halves of the rack. The handles provide easy manipulation during development.

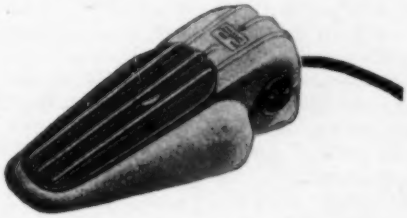
ENLARGING EASELS will remain steady and not slide around if sponge-rubber insulation is attached to the bottom as illustrated in the photo below. Such insulation is obtainable at automobile stores at nominal cost and is easily applied.—G. T. LUNDEEN.

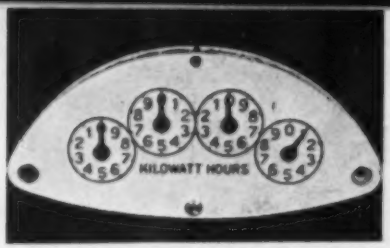




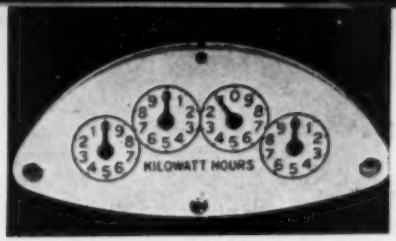
REMOTE CONTROL of a cable release can be rigged up as shown above. When one end of the line is attached to a support, a gentle pull will snap the shutter without jarring the camera.—D. F. B.

THIS FOOT SWITCH turns the safelight off as the enlarger goes on. Produced by the Industrial Timer Corporation, Newark, N. J., it incorporates a snap-action, single-pole, double-throw switch. There are two outlets for turning equipment on when the pedal is depressed and a third for simultaneously turning other equipment off. A neon pilot light under the pedal shows it in the dark.

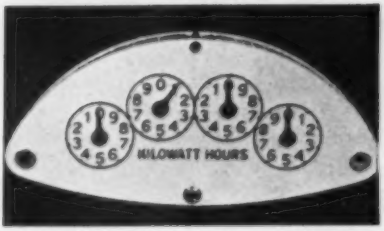




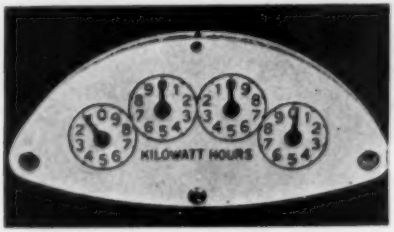
1 Use of one kilowatt hour moves the first pointer one digit and your bill says 0001.



2 Now the first pointer has moved around to 0 and the second goes to 1. That's 10 kwh.

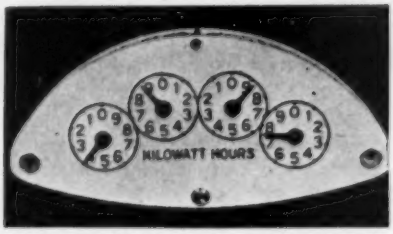


3 When both the first and second pointers are back at 0, the third shows 100 kwh.



4 With the fourth dial at 1 and all other pointers at 0, the meter reads 1,000 kwh.

5 This one is tougher. Count from the right and you see the correct reading is 2,345.

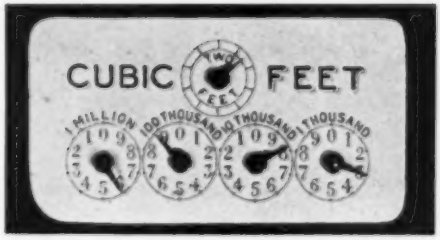


6 This reads 3,887. Subtract last month's reading to learn what you've used since.

READING GAS AND ELECTRIC METERS

IF YOU'RE sure last month's electric bill shouldn't be *that* high, you can check up by reading the meter yourself. Meters count kilowatt hours, the wattage multiplied by the number of hours of use and divided by 1,000. Thus, a 100-watt bulb burned for 10 hours would register 1 kwh. Of the four dials on an electric meter (Figs. 1-6), the one on the right counts single kilowatt hours, the hand moving clockwise one number for each kwh. used. The hand on the second dial moves counterclockwise one division for each 10 kwh., the third counts hundreds clockwise, and the fourth thousands counterclockwise. Hands turn in opposite directions, like a train of gears.

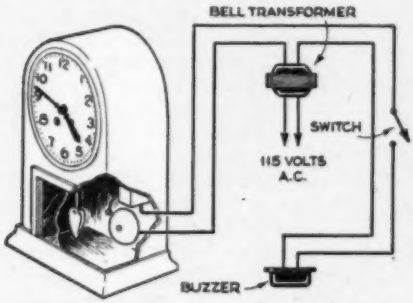
Gas meters, shown at right, are read in the same way, the unit of measurement being 1,000 cubic feet. The "two-feet" dial helps spot leaks.

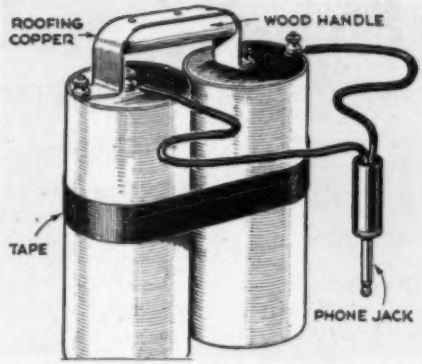


Counted the same way as electric meters are, the gas meter above registers 5,883,000 cubic feet, while the one below shows 328,000 cubic feet.

Buzzer Wired to Alarm Clock

SOMETIMES it is desirable to make a clock provide an alarm in a distant room. This can be done by wiring it in a buzzer circuit, provided the alarm bell is or can be insulated from the clockwork. Bend the hammer so that it remains on the bell and so closes the circuit when the alarm mechanism is tripped. The alarm spring need not be wound. Add a switch to shut off the buzzer after it has done its work.—BERT LARUE.



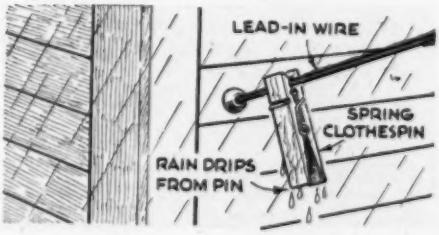


Handle for Booster Batteries

PORTABLE booster batteries for starting model gas planes are easier to carry if the two dry cells are connected with a handle of sheet copper or aluminum. Join one end to the negative terminal of one cell and the other to the positive terminal of the other cell; then fit in a rounded piece of wood to serve as a grip. Friction tape will hold the two cells together.—GEORGE MCGINNIS.

Clothespin on Wire Turns Rain

AERIAL lead-in wires that go directly into a house without a loop sometimes carry in rain water. A clothespin snapped on such a wire a few inches from the house is effective in preventing this. The water will run against it and drip off harmlessly before it can reach the wall.—FRED CORNELIUS.

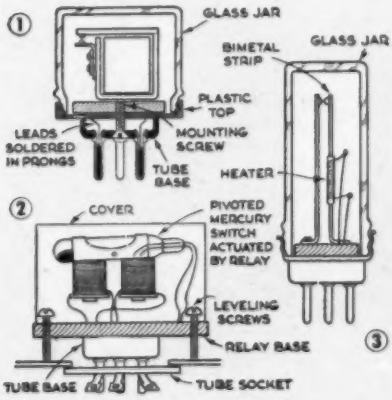


Relay Put on Radio-Tube Base

MOUNTING a relay on a radio-tube base has several advantages. Wiring is simplified, relays become interchangeable, and adjustments or repairs can be made to a relay without unsoldering connections.

Cut the tube base short and bolt a piece of ¼" bakelite or fiber to it as shown in Fig. 1. Drill holes in this piece for the leads, soldering them into the tube-base prongs. Relays and thermostatic elements can be protected from dust by clamping the lid of a wide-mouth jar between the fiber and the base and screwing the glass jar in place as a cover (Figs. 1 and 3).

If the relay must be leveled, tap the fiber for leveling screws as in Fig. 2.—D. H. M.



Two-Meter Handie Talkie

ADD THIS PORTABLE TRANSCEIVER TO YOUR LICENSED EQUIPMENT

By Harry R. Hyder

UNDER favorable conditions, a range of up to 30 miles is possible with this compact, self-contained transceiver, modeled on the handie talkie of the armed forces. It is designed for use on the new 144–148-mc. amateur band, and, in common with all high- and ultrahigh-frequency apparatus, its effective range depends on altitude. The farther the horizon, the greater the distance you can cover. But the power is all there—packed into a 5″ by 6″ by 9″ case. Licensed amateurs will find this portable rig a handy addition to their present stations.

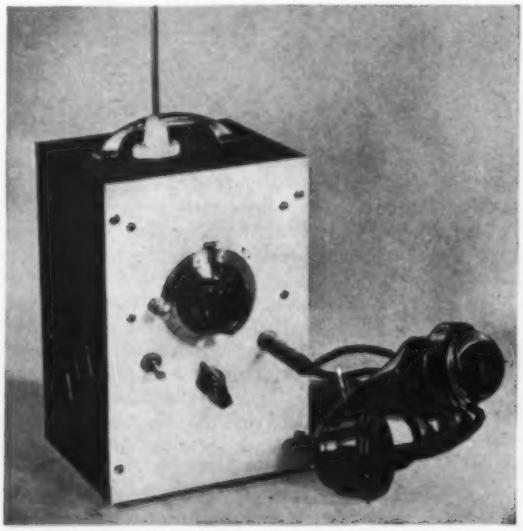
The circuit itself is simple; a 958A acts as a detector when receiving, and an oscillator when transmitting, and a 3Q4 doubles as an amplifier and a modulator in the same order. A single dry cell constitutes the filament supply of both tubes. For reliable operation on very-high frequencies, the familiar ultraudion detector-oscillator circuit is used.

Lead lengths are particularly important on these frequencies; in the oscillator, the terminals of one component are soldered directly to the terminals of another. The antenna is capacitively coupled to the grid end of the oscillator tank coil.

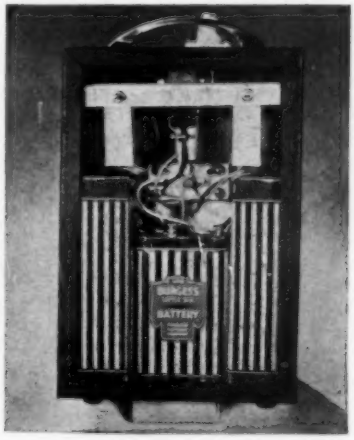
It is important that the stator of the tuning condenser go directly to the plate of the 958A, and the rotor to the grid, since the ultraudion oscillator depends for its feedback on the ratio of plate-to-filament and grid-to-filament capacities. With the condenser connected as shown, these capacities are just about right. All but one rotor and one stator plate were removed from a midget 6-plate 15-mmf. tuning condenser. The condenser and the acorn-tube socket are spaced from the chassis on ½″ ceramic pillars, and the shaft of the condenser is joined to the dial by a flexible coupling.

To make the two chokes (L2, L3) shown in the oscillator circuit, wind 25 turns of No. 22 enameled wire on 5-megohm, 1-watt resistors, and solder the ends of the wire to the resistor pigtails. Coat the coils with cellulose cement. For the oscillator coil (L1), wind 6 turns of No. 18 tinned wire to ¾″ inside diameter, spacing them to a total length of ½″. A transceiver transformer of the "microphone and plate-to-grid" type is used to couple the detector-oscillator to the amplifier-modulator.

Bias for the 3Q4 is supplied by a 350-ohm resistor in the negative B return; this reduces the total plate potential to 85 volts,



The complete transceiver, left, can be carried about conveniently. Careful placement of the parts is important both for compactness and to keep leads short.



but does away with the C battery; the filaments of the tubes are wired for 1.4-volt operation. Place a small shield over the tube to reduce R.F. pickup from the tank coil.

In transmitting, only the primary of the speaker output transformer is used, while in receiving half the primary is used, and the 2,000-ohm phone is connected to the voice-coil winding. This isn't good matching, but since the gain and output of the 3Q4 are rather high, enough power is delivered to the phones to give comfortable volume.

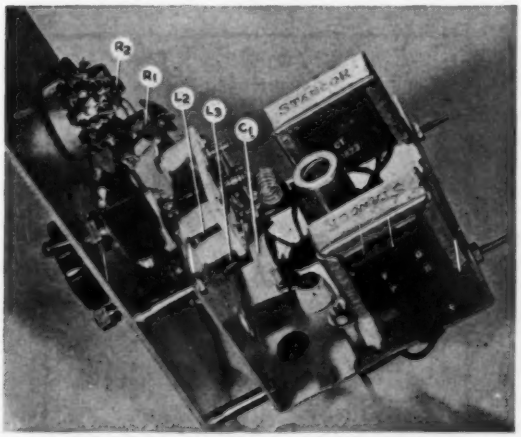
Current for the microphone is taken from a 1.5-volt dry-cell A battery. The handset contains a 200-ohm carbon microphone in addition to the 2,000-ohm receiver. A three-way jack on the front panel takes the matching plug on the handset.

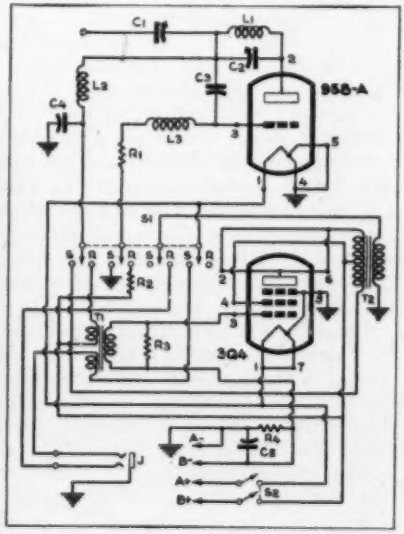
Try to get above nearby buildings when operating in a city.

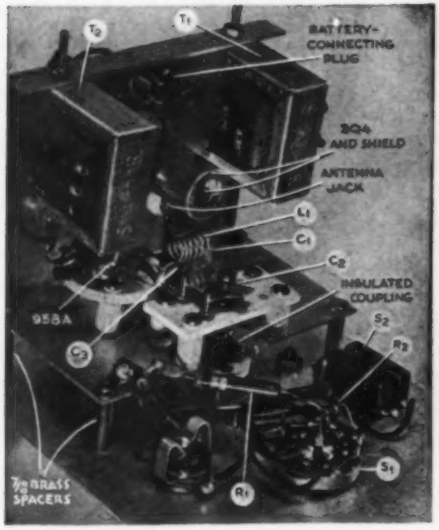
Part sizes must be kept to a minimum if the entire assembly is to fit properly into the container used for this model. Two 45-volt B batteries and a small 1½-volt A cell make a compact package, as can be seen in the right-hand photo on page 192. A 4-prong plug and socket assembly is used to connect the batteries to the set terminals, and facilitates removal of the batteries for checking and replacement. Screw four small rubber bumpers to the bottom of the can, and place over them a 5" by 6" sheet of ⅛" composition board with holes drilled in the corners to clear the bumpers. This board serves as a floor under the batteries.

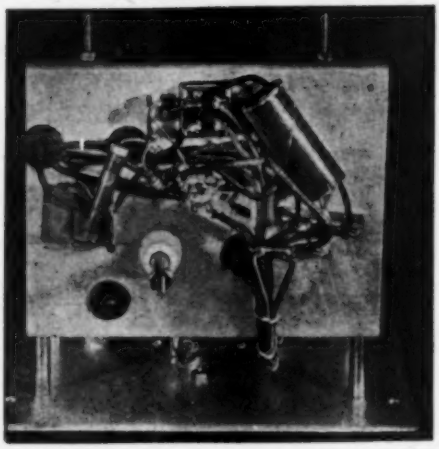
Mount the chassis, inverted, at the top of

Brass spacers ⅞" long are used to separate the chassis from the front panel. Both switches are mounted directly on the panel. The tuning condenser is built on a ceramic plate and spaced off on ½" pillars.









Most of the leads are brought around to the under side of the chassis, which becomes the top when the set is fitted in place. The antenna jack protrudes straight upward through the top of the case.

the front panel, spacing it from the panel with ⅞" brass collars. The screw for the antenna insulator projects through the hole at the top of the case. Two extra-length screws were used in mounting the transformers; these come out through holes drilled in the back cover. Resting in the holes, these screws help take up the weight of the chassis. Since it is not always possible to obtain the right part in the right size, you may find it preferable to wait until you have the entire unit assembled before determining the dimensions of the case.

A 27" length of 3/16" brass tubing is used for the antenna. Tap one end to fit the antenna insulator screw; this will probably require a 6-32 tap. While this holds the antenna in place, it does not provide much protection against vibration and movement. This deficiency can be corrected by bolting a 1" ceramic standoff insulator directly over the antenna clearance hole, and drilling out the core of the insulator to a diameter that will make it a close-fitting sleeve around the antenna rod.

If the transceiver has been wired correctly, it should work without additional adjustments. A rushing noise will be heard when the handset is plugged in and the change-over switch is turned to "receive" position. Rotate the dial slowly, and listen for signals. If the rushing stops at any point on the dial, the antenna is probably coupled too tightly, and the capacity of the coupling condenser, C1, should be reduced to the point where smooth superregeneration is obtained over the entire band. This is important in transmitting as well as in receiving.

The 144-148-mc. band covers about 25 divisions on the dial. Most of the stations operating on these frequencies are broad, modulated oscillators, and extremely sharp tuning is therefore unnecessary. If the band is not quite centered on the dial, compress or expand the tank coil until it is.

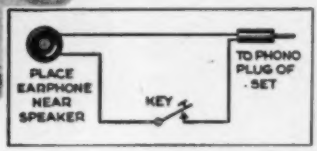
For easy portability, bolt a handle to the top of the case. Center the handle as nearly as possible, allowing clearance for the fingers around the antenna insulator.

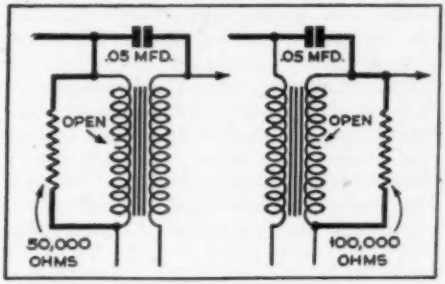
LIST OF PARTS

C1: 1.5 to 7 mmf. ceramic trimmer.
C2: modified 15-mmf. midget tuning cond., .017" air gap. See text.
C3: 50-mmf. mica.
C4: .003-mfd. mica.
C5: 20-mfd., 25-volt dry electrolytic.
R1: 20,000-ohm, ½-watt carbon.
R2: 4.7-meg., ¼-watt carbon.
R3: 470,000-ohm, ¼-watt carbon.
R4: 350-ohm, ½-watt carbon.
T1: Single-button microphone and plate-to-grid transformer.
T2: Universal speaker output transformer.
S1: Four-pole, two-position rotary switch.
S2: D.P.S.T. toggle switch.
J: Three-way jack.
L1: Tank coil. See text.
L2, L3: R.-F. chokes. See text.
Handset, 200-ohm carbon microphone and 2,000-ohm receiver.
Tubes, sockets, insulators, misc. accessories.

Radio Used for Group Code Work

ANY radio equipped with a phonograph jack can be quickly converted to a group code-practice set with a few extra parts. Connect an earphone, phono plug, and telegraph key as shown in the diagram. Ordinary line cord is suitable. When placed behind the radio loudspeaker near the voice coil, the earphone, which acts as a microphone, will make a feedback circuit providing a tone loud enough for a small group. Experiment with the earphone location until instantaneous feedback is obtained.—FRED STRAHM.





Shunt Makes Temporary Repair

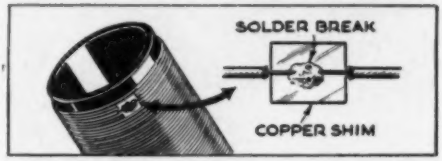
IF THE CAUSE of radio trouble has been identified as an open audio transformer and no replacement is available, a quick temporary repair with a resistor-condenser combination will put the set back in service immediately. Simply shunt the open side of the transformer with a resistor and couple with a condenser (see sketch).—A. G. M.

Matchstick Needles Cut Noise

PHONOGRAPH needles made from ordinary kitchen matches will reduce the pickup noise usually heard with open-type record players, while providing good reproduction with little loss at high frequencies.

Shorten a dry, soft-wood matchstick to about ¾" and whittle it to a diameter that will fit the pickup. Then make a perfectly pointed sharp tip. A cactus needle sharpener may be used, or the matchstick can be rotated in the chuck of a hand drill against sandpaper. Resharpen after each record for best results.—STEFFEN H. SORENSEN.

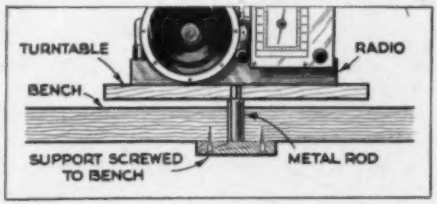
Shim Helps Repair Thin Wires



A SMALL piece of copper shim stock will help to solder thin wires when repairing radio coils and leads. Place a tinned shim under the broken ends of the wire and solder the ends on the shim. To prevent the iron from picking up the shim, hold it down with a toothpick. A few drops of tar, fingernail polish, or shellac will serve as insulation when the job is done.—P. T. POTTER.

Turntable Simplifies Servicing

RADIO servicing, which usually requires turning the set around many times, can be speeded up by using a turntable. Mount the turntable directly on the workbench, using a metal rod and wooden support arranged as shown in the sketch so that the turntable and rod can be removed when you don't need them.—ALAN GUDKNECHT.



NEWS IN ELECTRONICS

A RECHARGEABLE BATTERY powers this new General Electric portable receiver. The 2-volt storage battery can be charged by plugging the set into any 115-volt A.C. outlet, and the radio may be played at full volume while the cell is being renewed. About a cent's worth of electricity keeps the battery in operation for 20 hours. A similar radio was introduced by G. E. before the war.

SIMULTANEOUS VISUAL RECEPTION of a broad band of radio signals is made possible by the adapter shown above. When the "Panadaptor" is attached to any superheterodyne receiver, its cathode-ray screen scans a band 200 kc. wide. The signal to which the receiver is tuned shows up as a trace in the center of the screen, while neighboring stations are seen but not heard. The type and strength of these signals, as well as their frequency, are indicated by the cathode-ray beam.

Up to now this instrument, which is made by the Panoramic Radio Corporation, of New York, has been used chiefly for wartime monitoring of the airwaves. It is now being converted to peaceful uses. Some of these include listening for short-wave and amateur broadcasts that are often missed in aural tuning, and monitoring of occasional and emergency calls in aircraft communication.

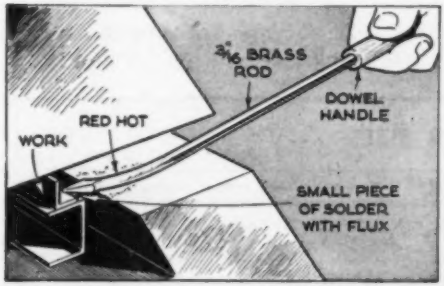
MOBILE RADIOTELEPHONES permit the occupant of a vehicle to call or be called by practically any telephone in the country. Equipment is now in use in the St. Louis, Mo. area, where the first commercial installation has been made by the Bell System. Calls originating in a car are broadcast to a relay station, from which they are carried to their destination over regular telephone lines. It is planned to extend the service to other principal cities, as well as to some of the more important intercity highways.

Colored Identification Disks

ADHESIVE cellulose tape in various colors can be cut into identification disks for office, home, or workshop use. Attach a strip to wax paper and cut a series of holes in it with a punch. The backed disks can be kept in an envelope and peeled off for use as needed.—F.S.

How to Paint Galvanized Iron

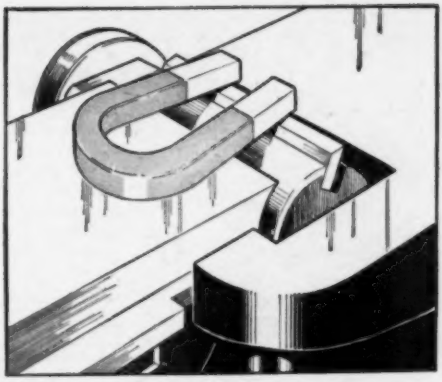
WHEN painting galvanized sheet iron, it is advisable to wash the surface first with vinegar and soda, for otherwise the paint may peel off after a short time. Allow the vinegar and soda mixture to stand for awhile on the surface and then remove all traces before applying the paint.



Soldering in Tight Corners

IF A SOLDERING iron won't reach some spots in model building or on other small jobs, make a new iron with a bent tip, as shown above. The iron may be a length of 3/16" or ¼" brass with a wood dowel for a handle. File a point on the tip.

Place solder and flux on the work, heat the rod tip red, and touch it to the work. Once will do for small jobs, but reheating will be needed on others—HERBERT PFISTER.

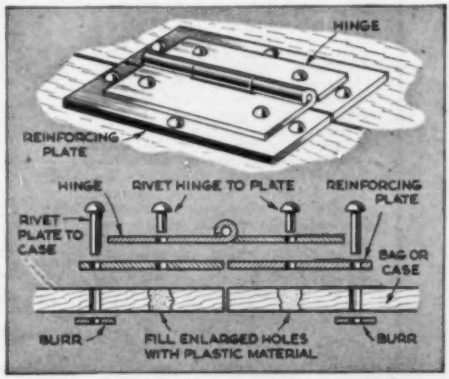


Replacing Blades in Jointer

WHEN jointer blades have been taken out for sharpening, they are sometimes hard to keep in alignment while being replaced in the cutting wheel. A horseshoe magnet laid on the rear table of the jointer, however, will hold them in exactly the desired position for tightening.—PARKER HART.

Repair Kink for Small Hinge

SOMETIMES a small hinge pulls out of a suitcase or cabinet, tearing the holes so the hinge can't be replaced in the same position. If the leaves are too small for new holes or it would spoil the piece to move the hinge to a new position, cut larger leaves from sheet brass and rivet them to the old leaves. New holes can then be drilled in the larger leaves well outside the old holes so the mounting screws or rivets can take firm hold. The extension leaves should be of about the same thickness as the original ones, though they can be a bit thinner.—W. E. B.

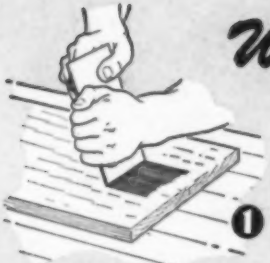


What's Wrong?

Do you like to work with veneers? Then you should know the errors in these drawings. The answers are given below.

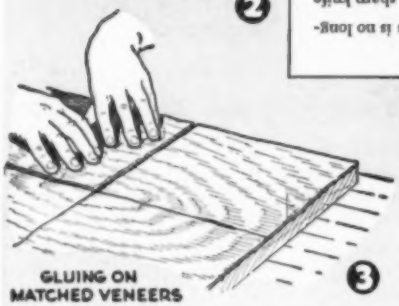
ANSWERS

1. Toothing of cores is no longer felt good practice.
2. Don't saw. Use a sharp knife and a heavy straightedge to hold the veneer flat.
3. Matching veneers are taped at joints and glued as one sheet. Don't veneer over solid stock.
4. A veneer of similar shrinking characteristics is glued to the back of the core at the same time to balance the pull of the face.
5. Inlay assemblies need padding to equalize pressure.
6. When veneering a curved piece, use a form of the exact curve on each side, or use forms with enough bars for almost continuous pressure. Apply the first clamps at the center to allow veneer adjustment toward the ends.

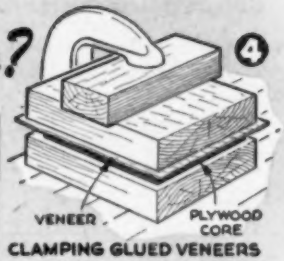


TOOTHING A CORE FOR VENEERING

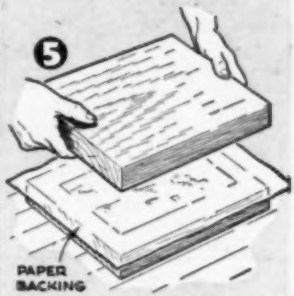
SAWING VENEER



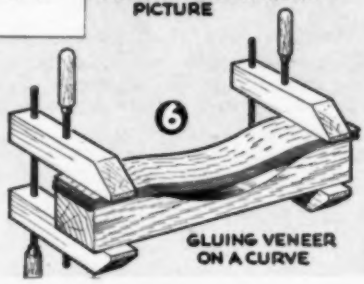
GLUING ON MATCHED VENEERS



CLAMPING GLUED VENEERS



ASSEMBLING AN INLAY PICTURE



GLUING VENEER ON A CURVE

ROUGH AND DRESSED LUMBER SIZES [WOODWORKING]

When you buy a dressed two-by-four, you get a piece of lumber that actually measures 1⅝" by 3⅝", the difference having been planed away in the process of dressing. All dressed lumber is thus reduced in size to some extent, the amount depending upon the number of sides planed. This reduction, however, is not a hit-or-miss affair left to the whim of any particular mill operator; it is guided by standards established by the National Bureau of Standards with the cooperation of representative manufacturers and lumber users.

The table at right gives standard dressed sizes for yard and structural lumber, the type most widely used. Standard sizes are slightly different in the case of factory and shop lumber intended for use by industrial plants that resaw it or work it up into other products.

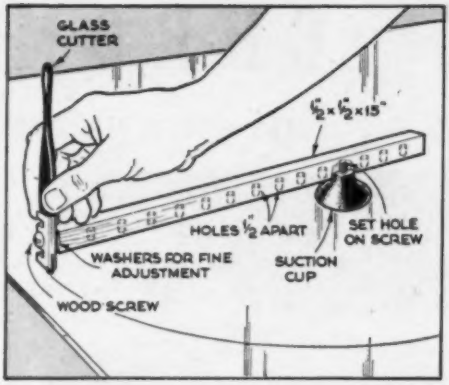
THICKNESSES (Inches)		NOMINAL AND ROUGH WIDTHS (Inches)							
Nominal and Rough	Dressed	2	3	4	5	6	7	8	Wider than 8
		WIDTHS OF DRESSED SIZES							
1	25/32	1⅝	2⅝	3⅝	4⅝	5⅝	6⅝	7½	½ off
1¼	1 1/16	"	"	"	"	"	"	"	"
1½	1 5/16	"	"	"	"	"	"	"	"
2	1 5/8	"	"	"	"	"	"	"	"
2½	2 1/8	"	"	"	"	"	"	"	"
3	2 5/8	—	"	"	"	"	"	"	"
4	3 5/8	—	—	"	"	"	"	"	"
5	4 1/2	—	—	—	4½	5½	6½	7½	"
6	5 1/2	—	—	—	—	"	"	"	"
7	6 1/2	—	—	—	—	—	"	"	"
8	7 1/2	—	—	—	—	—	—	"	"
Thicker than 8 ½ off		—	—	—	—	—	—	—	"

S4S (surfaced four sides), S1S1E (surfaced 1 side and 1 edge), S2S1E, and S1S2E sizes are the same.
S1S or S2S—Dressed thickness by nominal or rough width.
S1E or S2E—Dressed width by nominal or rough thickness.

POPULAR SCIENCE MONTHLY SHOP DATA

Homemade Rig Cuts Glass Disks

WITH an ordinary wheel-type glass cutter and a suction cup you can cut disks of any size. Drill the cutter shank as shown and with a screw fasten it to the end of a ½" square stick. At ½" intervals along the stick drill holes of a size to fit on the screw of a suction-cup coat hanger when the hanger is removed. Press the cup on the glass and set the stick to the required radius. Use washers for in-between adjustment as shown at the right. The cut should be made with a single pass of the cutter to avoid dulling the hardened wheel.—H. P.



Excelsior Replaces Brush for Cleaning Soot from Furnace

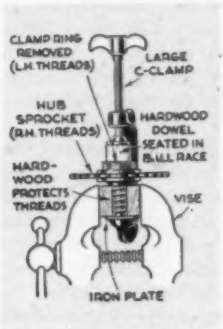
IF A WIRE flue-cleaning brush is not at hand, excelsior makes a fair substitute. Simply grasp a wad of it in the clinker tongs and use it like a brush to remove soot deposits that cannot be reached with the scraper. When the work is done, the excelsior can be ignited in the flue. It will burn with almost no residue. If you have no tongs, bind the excelsior with wire to an iron rod or a dowel.—W. E. L.

Home Owner Burns Down Tree with Electrically Heated Wire

WANTING to cut down a large black locust tree in his back yard, H. W. Bousman, of Schenectady, N. Y., an engineer of the General Electric Co., turned to the tools of his trade. He burned the tree down with electricity.

A 15" length of No. 12 nichrome wire was looped about the tree and connected to the low-voltage side of a step-down transformer. Weights applied tension to draw the red-hot wire through the wood. As a safety measure the upper branches were cut this way first; then the trunk was cut down in sections, with ropes tied to them to insure their falling in a way to cause no damage. Limbs burned through rapidly, but it took all night to cut through the 10" trunk. However, Mr. Bousman suggests that a heavier resistance wire might work faster. Even a large tree could be burned down in one cut.

C-Clamp Aids in Removal of Bike Sprocket

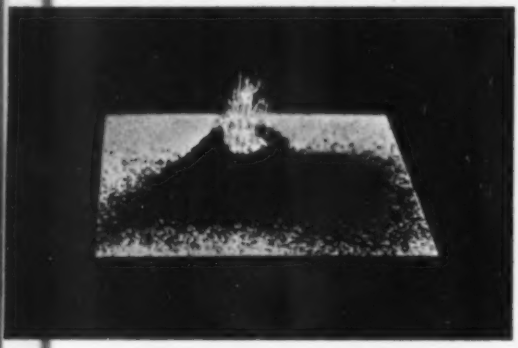


TO REMOVE the sprocket from a bicycle driving-worm assembly, the latter is usually clamped between blocks in a vise, and the turning effort required to loosen the sprocket tends to screw the worm out of the blocks. If a piece of hardwood dowel is seated in the ball race and a C-clamp applied as at the left, a wrench or a punch and hammer used as shown at right will quickly free the sprocket. Be careful not to burr or mar any part.—R. S. MACNEILL.

CHROMIUM

TOUGH GUY OF THE METAL FAMILY

Orange-red ammonium bichromate decomposes in lively fashion when ignited, giving off steam and nitrogen amid a display of pyrotechnics.



In a darkened room the reaction resembles a miniature volcano, shooting out red sparks and vapor and producing a lavalike ash.

There is left green chromic oxide, a pigment used in coloring glass, enamels, and pottery.

Its Hardness Makes Steel More Durable and Its Colors Vie with the Rainbow

By KENNETH M. SWEZEY

BRIGHT, silvery-white metallic chromium is almost as hard as a diamond and as tarnishproof as gold. Deposited electrically over iron and steel, pure chromium has almost entirely displaced nickel as a wear-resisting decorative coating for household appliances, automobile trim, and machine parts. Because of their extremely hard surface, chromium-plated gears, gauges, dies, and printing plates are tougher than those of unplated case-hardened steel.

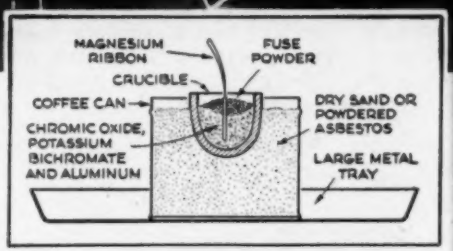
Mixed in small quantities with iron and steel, chromium increases strength and resistance to corrosion without increasing brittleness, though chromium itself is very brittle and can be broken quite easily. Safes, projectiles, automobile and airplane engines, high-speed tool steels, big guns, and battleship armor plate all contain from 1 to 2 percent chromium. Rustless iron and stainless steel contain about 14 percent. Nichrome, an alloy of chromium with nickel, is widely used in the form of wire as a resistance element for electric heaters.

It was not the silvery metal but the compounds of chromium that gave this element its name. The word "chromium" is derived from the Greek *chroma*, which means "color." Compounds of chromium range through every color in the spectrum. The green of the emerald and the red of the ruby are both due to traces of chromium. Chromic compounds are generally violet or green. Chromous compounds are blue. Lead chromates, used as pigments and dyes, are yellow and orange. Bichromates, also known as dichromates, are usually orange-red.

With ½ oz. of ammonium bichromate you can perform a novel experiment having a surprise ending. This experiment also introduces you to several colors of the chromium rainbow and provides you with a chemical from which you can make chromium metal.

Heap the ammonium bichromate in the form of a low cone on the center of an asbestos

Chromic oxide mixed with aluminum powder and then ignited reacts violently to leave molten chromium that hardens quickly into a button of pure metal. Use a crucible like that in the drawing.



mat or the bottom of an upturned cake tin. Then light the top of the cone with a match. As soon as the chemical starts to burn continuously, turn out the lights. Your little mound now looks like an erupting volcano, shooting forth red sparks from its crater and giving off a voluminous ash that resembles lava. When the eruption ends, turn on the lights again. In place of the little heap of orange-red compound, you'll find a mound of olive-green chromic oxide. The burning is really a decomposition in which nitrogen and water are broken free from the $(NH_4)_2Cr_2O_7$, leaving a puffed-up residue of chromic oxide, Cr_2O_3.

This chrome oxide green is a permanent, non-fading pigment used for coloring glass, enamels, pottery, and the like. It is not the more fugitive color known simply as chrome green or Brunswick green, which is formed by combining Prussian blue with chrome yellow and is used as a pigment in oils, printing inks, and textile prints.

By combining finely granulated aluminum with part of your chromic oxide and igniting it, you can perform an experiment more spectacular than the first. In this experiment, aluminum plunders oxygen from the chromic compound—and at the same time raises the temperature to more than 1,600 deg. C. and releases a button of molten chromium. Pure chromium is produced commercially by this same reaction, called Goldschmidt's process of aluminothermy.

This experiment is not dangerous if you limit the chemicals to very small quantities, perform it outdoors or in a room with a bare concrete or wood floor, and keep out of range of sparks, which fly 3′ or 4′. Protect

Chromium metal is quite brittle and may be broken with pliers, but it is so hard that a sharp edge will scratch glass or steel. It is silvery and resists corrosion.

your eyes also with dark goggles or a sheet of smoked glass so you can watch the intense glow with safety.

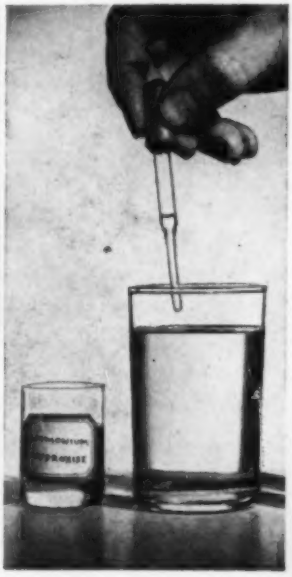
For a melting pot use a small, replaceable fire-clay or porcelain crucible. To conserve heat for the reaction, as well as for the sake of personal safety, embed this crucible to its rim in a coffee can filled with powdered asbestos or dry sand. Set this in a larger metal tray or pan to catch near-by particles.

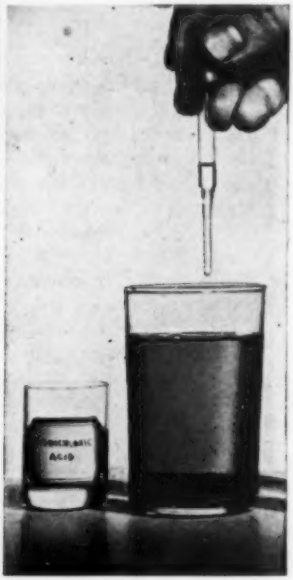
You will find that you can squeeze chromic oxide to much less than its fluffed-up volume. This done, heat it to redness in an iron pan for a few minutes to drive out moisture. Then melt 2 grams of potassium bichromate in another pan, allow it to cool, and powder it in a mortar. Weigh out 10 grams of chromic oxide, add this to the potassium bichromate, and in addition put in 2 grams of finely granulated aluminum (coarse powder). Mix these three substances thoroughly and pack your crucible.

A fuse powder is needed to bring this mixture to a temperature high enough to start the reaction. This can be made by mixing ½ gram of powdered aluminum with ½ gram of potassium perchlorate. Now make a little depression in the center of the chromium mixture, pour in most of the fuse powder, and spread the remainder over the top of the mixture. Then insert a 4″ length of magnesium ribbon, pushing it through the powder to the bottom of the crucible.

To start the reaction, carefully light the end of the magnesium ribbon and stand quickly at least 4′ or 5′ back. The effect is most startling in a darkened room. Amid intense light, heat, smoke, and fireworks, the aluminum robs your green chromic oxide and red potassium bichromate of oxygen, freeing the chromium from both compounds.

When the crucible has finally cooled, break it open and remove the button of chromium. You will find this metal brittle enough to break with pliers, but a sharp corner of the break will be hard enough to





Orange-red bichromate is changed to yellow chromate by the addition of a base to a solution of bichromate, and is changed back again by adding acid. Dissolve potassium bichromate in water, as above, and add a little ammonium hydroxide. The orange-red solution becomes pale yellow. Add a few drops of hydrochloric acid, as at far right, and the solution again becomes the original orange-red.

put scratches on glass or ordinary steel.

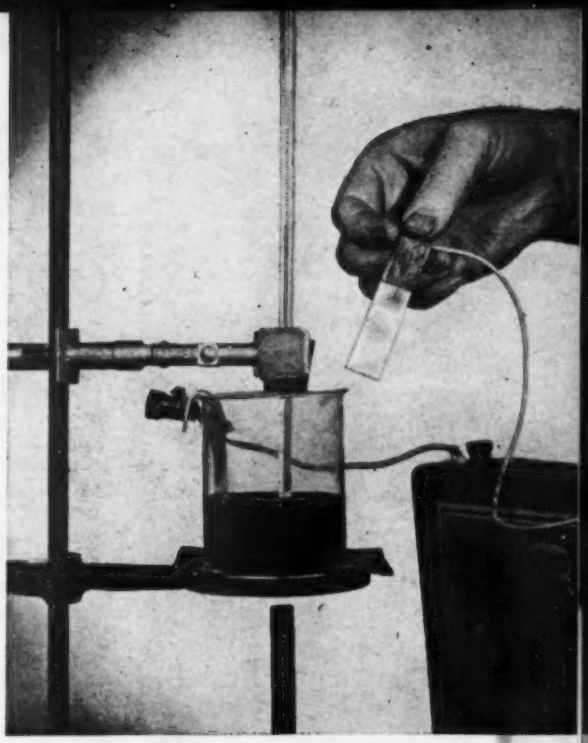
Potassium chrome alum, one of the commonest chromium compounds, is a double sulphate of potassium and chromium. It has exactly the same formula as ordinary potassium alum, but with chromium substituted for aluminum. It is used in tanning, as a hardener in photography, and as a mordant for dyes.

You can make chromium hydroxide by dissolving some potassium chrome alum in cold water to form a violet solution and adding ammonium hydroxide. A green-gray precipitate of hydroxide is formed, and this may then be washed and dried. When this green-gray hydroxide is heated strongly, green chromic oxide is the result.

Potassium bichromate, an orange-red crystalline salt, is probably the most used of the chromium compounds and the one from which most of the other compounds are made. It shares with other bichromates the feature of being capable of changing to a yellow chromate when in solution merely by the addition of a base. Dissolve some potassium bichromate in water and add, with stirring, a little ammonium hydroxide. Suddenly the change of color indicates the change in chemical composition. Likewise, by adding a little mineral acid (hydrochloric or sulphuric) to the yellow chromate solution, it will be quickly changed back to orange-red bichromate.

The development of satisfactory methods of plating with chromium from solutions of chromium trioxide has revolutionized the whole plating industry within the last 20 years. All the best methods are patented and cannot be used commercially without license, but you can easily demonstrate the principle in your home lab. You will need some chromium trioxide (chromic acid), concentrated sulphuric acid, a 6-volt battery, and a 1" by 3" lead plate as an anode.

For your plating solution, dissolve in a 250-ml. beaker 40 grams of the red chromium trioxide crystals in 100 ml. of water. (CAUTION: *Be careful in handling this substance. It is a powerful oxidizing agent and reacts destructively with many organic materials, including cloth, paper, and skin. If you spill any on yourself, rinse immediately with plenty of water.*) To this solution add 12 drops (about .25 ml.) of concentrated sulphuric acid.

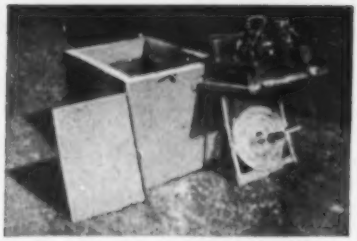


Chromium from a solution of chromium trioxide is plated directly on metals by electrolysis. The plating depends on temperature, concentration, and current strength.

Set up the beaker on a ring stand over a Bunsen burner and support a thermometer to reach well into the solution. Bend one end of the lead anode, hook it over the side of the beaker, and connect it with a wire to the positive pole of your battery. Bring the temperature of your bath to about 45 deg. C. before you try to plate anything, and keep it there during the plating.

The character of chromium plating—whether it turns out to be dull or bright, or whether it takes place at all—depends upon careful control of the strength of the bath, the temperature of the bath, and the strength of the electric current. A bright plating should be obtained on smooth, clean metal surfaces with the concentration and temperature specified and current of 1 amp. per square inch of surface being plated.

Plating is most easily done on bright copper or nickel surfaces, which should be connected by a wire to the negative pole of the battery and lowered into the bath. The current may be regulated somewhat by moving the object being plated closer to the lead anode or farther from it, or a small radio rheostat may be connected in the circuit.



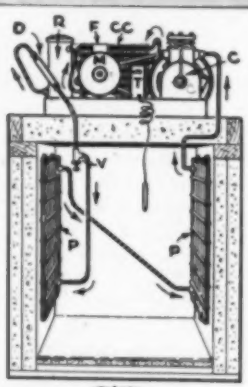
Food Freezer Built from Secondhand Milk Cooler Operates at Low Cost

OBTAINED secondhand, the milk cooler shown in the photo at the top left was converted into the food freezer in the lower photo at a total cost of about $115. The operating cost of the freezer is between $1.50 and $2.50 monthly.

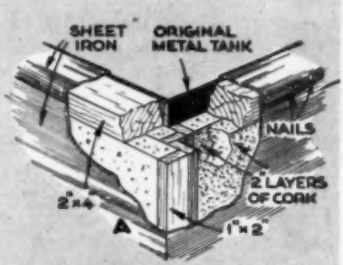
When buying a cooler for conversion, make sure the motor and compressor are in good shape. Some of the better coolers may not need to be changed except to install freezer plates in place of the cooling coils and a temperature control to give you a lower temperature. You can obtain the plates from almost any commercial refrigeration concern.

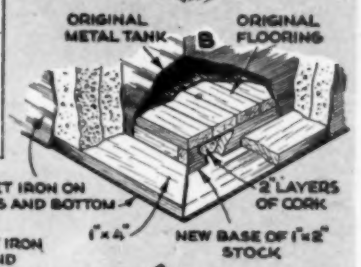
In my particular conversion, the old insulation was in bad shape and had to be replaced. The drawings below show how this was done. Hangers to support the freezer plates either can be bought or made as shown. In installing the plates and copper tubing, be careful to place the intake opening at the bottom.

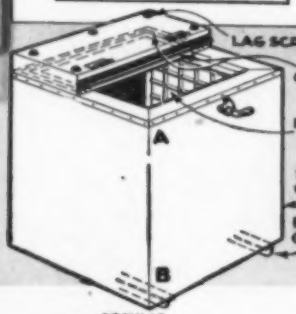
Several kinds of refrigerant are available. Among those commonly used in milk coolers are methyl chloride and freon. Either of these performs well in a home freezer, between 3 and 4 lb. being required for a system of this size.—RALPH S. WILKES.

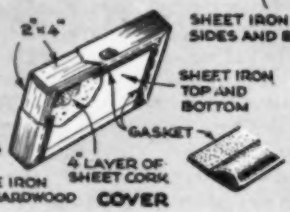


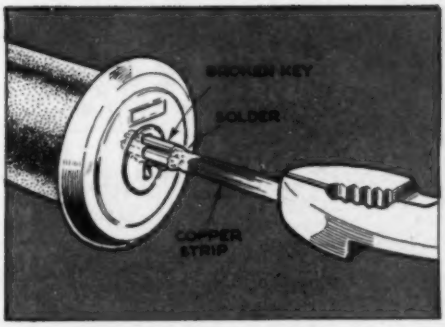
Freezers make use of the fact that a liquid absorbs heat while expanding into a gas. Driven by the motor (M), the compressor (C) compresses the gas refrigerant coming from the plates (P). This heats up the gas, but the fan (F) blows this heat away as the refrigerant passes through the condenser (CC). The refrigerant, now a liquid, flows from the receiver (R) through the drier (D) to the automatic expansion valve (V) from where it expands into the plates, taking heat from the stored food and returning to the compressor as a heat-laden gas. Temperature is regulated by the automatic control (T).









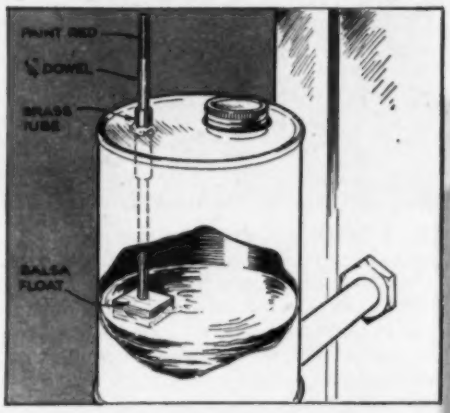


Removing Broken Key from Lock

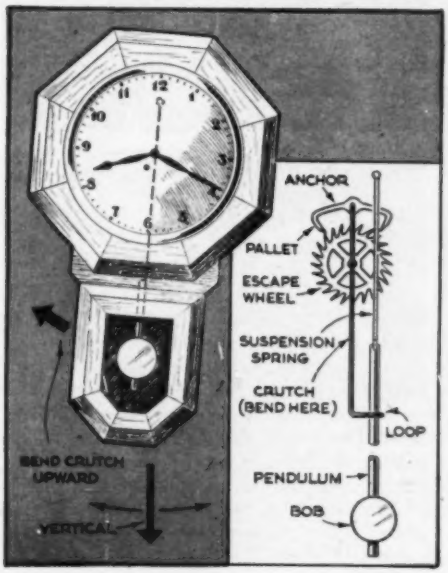
After unsuccessfully trying tweezers and other means to remove a broken key from an auto door lock, I did the job with a soldering iron. A globule of solder was melted on one end of a strip of copper, and a drop of fluid flux put on the broken key with a toothpick. The copper strip was then inserted to touch the key, and heated at the outer end. When the solder melted, it joined the strip to the key, which was then pulled out.—Philip M. Rizzo.

Gauge Shows Oil in Stove Tank

However smart you may be at second-guessing radio quiz programs, one bad guess as to the oil left in your stove can leave you in the cold. To avoid this, I built a simple gauge as shown at the right. The wooden parts were given several coats of lacquer, and the top of the dowel was painted red. When only red shows, it's time to get out your can and fill 'er up. But this is good only for a tank that is fixed to the stove and filled from the top. It won't work on the removable type that is inverted over a reservoir, as such a tank must be airtight at the top when inverted.—J. G. Lownsbery.



How to Make a Pendulum Clock Run Properly When Hung Plumb



Some pendulum clocks stop running unless they are hung in a tilted position. The way to correct this is to bend the pendulum slightly toward the "uphill" side as shown at left. The right place to make the bend is in the crutch that links the anchor with the pendulum. This can be bent with the fingers of one hand.

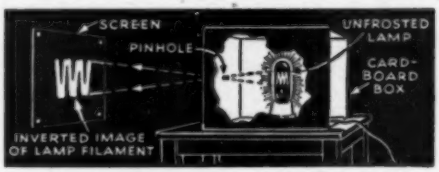
Remove the face or back of the clock if necessary to gain access to the crutch. Make the bend and level the clock. Start the pendulum with the least possible swing and listen to the ticks and tocks. They should be equally loud and with equal intervals between them. If not, tilt the clock as necessary to equalize them, bend the crutch upward as indicated, and test again with the clock hung plumb.

A bit of fine clock oil should be put on the pallets where they touch the escape wheel. The crutch loop should have a minimum of slackness on the pendulum rod, but must not bind.—William Schopp.

How LIGHT TRICKS Our SIGHT

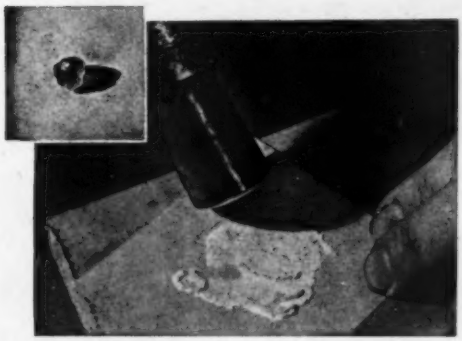
BLUE SKIES and orange sunsets are due to selective reflection of light. As white light from the sun streams through the atmosphere, particles of dust and other matter reflect violet and blue rays, causing the sky to appear blue and the sun yellow. With a flashlight and water containing a few drops of milk, you can witness the same thing in a darkened room. Look directly through the glass and the light appears yellow; look from the side and the liquid is blue. At dawn and dusk, the sun may deepen in color through orange and red because more violet and blue are reflected as the rays pass through more miles of atmosphere. If more milk is added, your light will darken in the same way.

WE SEE COLORS because light rays of those particular colors are reflected to our eyes. But how does a colored object appear in a light that contains no rays of its own color? Try it by moistening some borax with denatured alcohol, lighting it, and viewing a colored picture in an otherwise dark room. Because a burning sodium salt produces light only in the yellow band of the spectrum, the picture appears yellowish-gray.



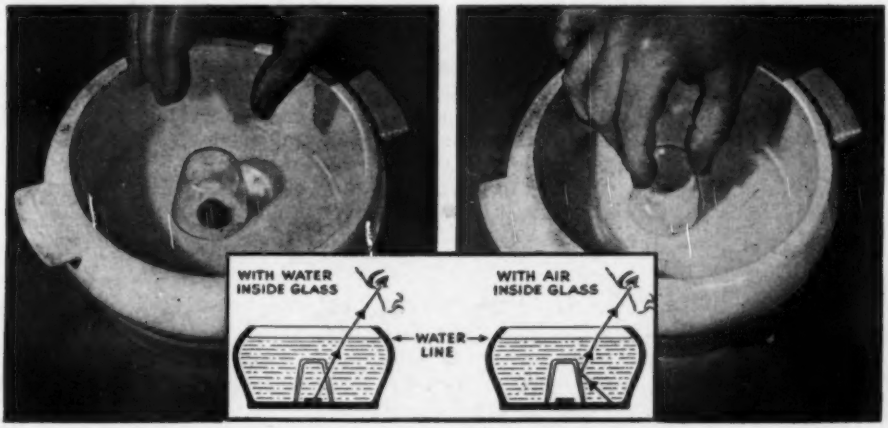
LIGHT WAVES travel in straight lines. Because of this it is possible to form an image on a screen with the help of the pinhole setup shown above, the image being inverted as in a camera. The size of the image may be varied by changing the distance from the pinhole to the screen or from the pinhole to the light source. If you make a larger pinhole a little above the original hole and a smaller one below, you can produce three separate images. These will vary in brightness and sharpness, the largest giving the brightest but least clear image and the smallest the dimmest but sharpest. This pinhole principle may be employed in a simple camera, a very small hole pricked in metal foil taking the place of a lens.

COLOR SENSITIVITY of the human eye shifts from the red toward the blue end of the spectrum as illumination dims. This fact, discovered by the Czech physiologist Purkinje, can be demonstrated by covering a flashlight with sufficient white cloth or tissue paper so you can barely see objects by its light in a dark room. In this light, green and blue seem to be relatively brighter while red and yellow are darker. By increasing the light intensity gradually, you will find a point where this comparative brightness reverses itself. Because of the "Purkinje effect," colors in the country seem to change at twilight.



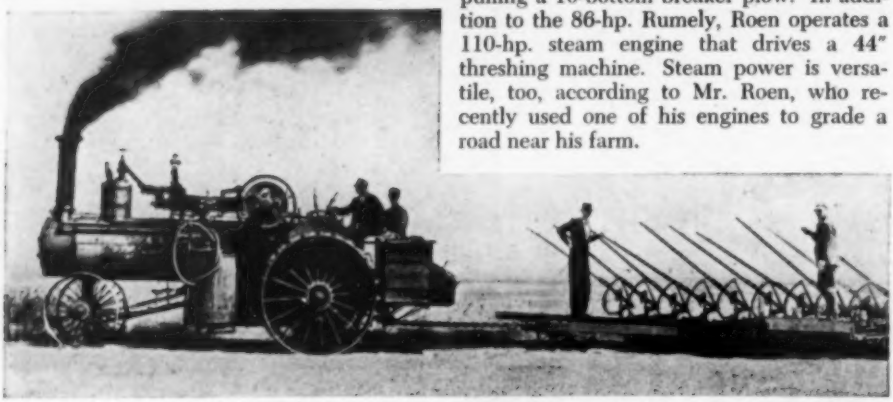
TRANSPARENT SUBSTANCES such as glass are a certain color because they partly transmit and partly reflect the color observed while absorbing all other colors. To retain this color, the substance must be in pieces that are large compared with the minute wavelengths of light. You can show this with a crystal of copper sulphate. Ordinarily, this crystal is a deep blue, but powder it finely with a hammer, as at the left, and the color disappears. This is because the light rays, unable to penetrate the tiny particles, are scattered in all directions at the surface.

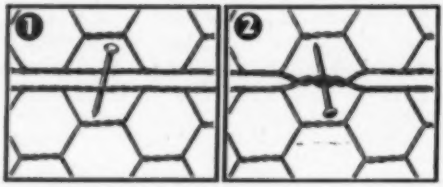
HERE IS A VANISHING COIN trick in new dress. With water in the glass, the coin is visible. But lower the glass without letting in water and the coin cannot be seen from the angle shown. (You can always see it by looking straight down.) In the first case, light rays are reflected almost in a straight line. In the second, the rays cannot pass from water to air, or vice versa, at the steep angle indicated, the air-water surface acting like an opaque mirror and totally reflecting all rays that strike at this angle.



FOR EASIER FARMING

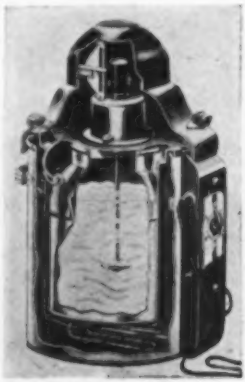
ONE TON OF COAL plows 40 acres in less than a day. D. H. Roen, who has a farm near Comstock, Minn., gets this performance from a 1914 coal-burning Rumely steamer pulling a 10-bottom breaker plow. In addition to the 86-hp. Rumely, Roen operates a 110-hp. steam engine that drives a 44" threshing machine. Steam power is versatile, too, according to Mr. Roen, who recently used one of his engines to grade a road near his farm.





CHICKEN-WIRE JOINTS can be made quickly and permanently by twisting the adjacent end wires of the mesh around a 6d. nail as illustrated above. A double turn before withdrawing the nail is sufficient in most cases. Twists should be spaced 4" to 6" apart.—ARTHUR W. CLIFFORD.

A WALKING TRACTOR for garden plowing was built by William A. Loumaster, of Atlanta, Mo., around a transmission, differential, and rear axle taken from a junked Model A Ford. Welded to the tractor is a five-prong spring-tooth cultivator. The clutch, operated from the handles, is a simple belt tightener. An air-cooled engine drives the wheels.—J. G. MACKENZIE.



PASTEURIZING MILK is a one-hour job for the family-size device shown at left. Its 2-gal. container is immersed in a water jacket that maintains a uniform temperature while a plunger agitates the milk. The pasteurizer is made by the Guard-It Manufacturing Co., of Chicago, and can be operated from any 115-volt A. C. outlet.

WARNING OF FREEZER FAILURE is given by this battery-operated alarm. It is controlled by a thermostatic switch, and is independent of line current. The Freezrlarm Co., of Dayton, is the manufacturer.

Any camera's a color camera

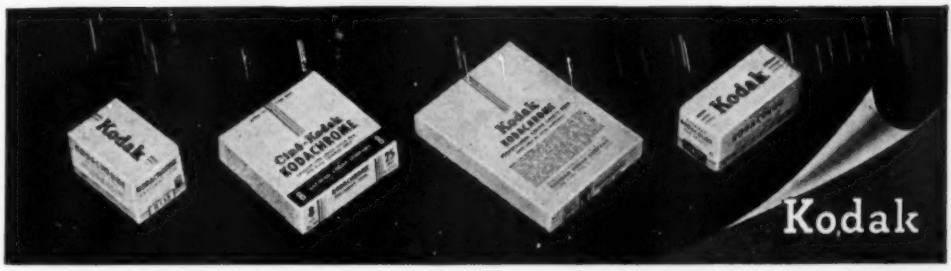
...loaded with a Kodak color film

Your camera—everybody's camera—is a "color camera" as is. No special lens is necessary, no extra attachments. Just load with the Kodak color film your camera takes—Kodacolor for popular-size roll-film cameras; Kodachrome for miniature, sheet-film, and home-movie cameras. And you're ready for the new and exciting world of color photography.

See your Kodak dealer—he's headquarters for color films and prints . . . Eastman Kodak Co., Rochester 4, N. Y.

Good News!

A new size in Kodachrome Prints —3X, measuring 3 x 4¾ inches —for only 85¢. New low price, too, on 2X Kodachrome Prints, 60¢ . . . and on Kodacolor Prints, 30¢. Minimum charge per order, $1.



But what's the idea of the scales, Mister?

It's a speed test, and the scales are the referee. It's a Nicholson-factory performance test to check a file's cutting speed and wearing qualities.

Test bars of various materials are used. The uniform strokes of an expert on filing technique and pressure are counted—with the bar being carefully weighed before and after the operation to determine the amount of material removed. Numerous other tests and inspections—from bar steel to final oiling—characterize the manufacture of Nicholson and Black Diamond files.

File making is the Nicholson Company's sole business. This is what enables Nicholson to assure *The right file for the job* and to guarantee *Twelve perfect files in every dozen.* Sold through hardware and mill-supply houses.

FREE BOOK, "FILE FILOSOPHY" (*profusely illustrated*), on kinds, use and care of files. For home and industrial craftsmen, farmers, production heads.

NICHOLSON U.S.A.

NICHOLSON FILE CO.
19 Acorn St., Providence, 1, R. I.
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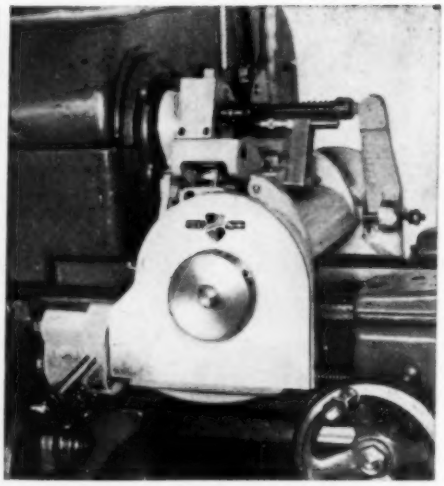
NICHOLSON FILES *FOR EVERY PURPOSE*



Automatic Lathe Attachment

An attachment for small bench lathes provides a means of producing small parts automatically, with high accuracy and low cost. The Dunamatic, a product of the Dunn Engineering Co., Detroit, Mich., uses face cams to control the operation of rocker arms, which in turn control the action of tools attached to them. The rocker arms operate precision-ground pivots instead of flat-surface slides, making constant adjustment unnecessary.

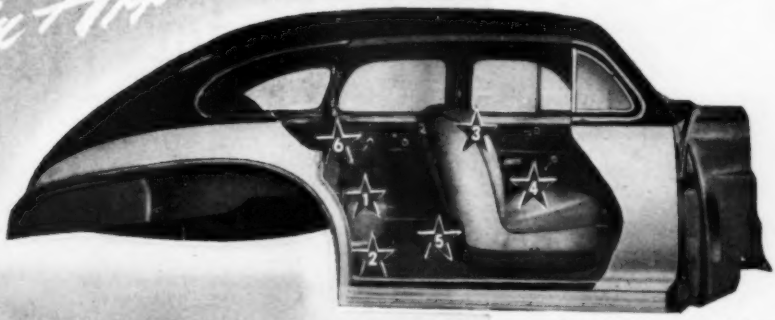
Stock is automatically cam-fed by fingers through a tube into a collet. A moving stock stop determines the length of the part. The collet closes automatically as the work tools start operating. No holes need be drilled in the lathe in attachment.

Self-Clinching Rivet

Plywood interior walls may now be easily fastened to steel sections of trucks and house trailers with the washer-head Rivnut, developed by The B. F. Goodrich Co. It is a cadmium-plated blind rivet, upset by means of a special tool that engages its internally threaded shank. When the tool is retracted, a bulge forms in the shank that locks the fastening device.

BETTER BY FAR

in Appointments



1. Rear seat luxuriously upholstered, with comfortable armrest on each side.
2. Attractively designed scuff pads add to the appearance of door bottoms and seats, as well as protect them from wear.
3. The smartness of door interiors and window moldings are tastefully ornamented with polished stainless steel.
4. Pull-to armrests are leather surfaced on the top and decoratively trimmed.
5. Footrest is recessed into back of front seat to give maximum legroom.
6. Smartly designed appointments by Ternstedt* include: assist strap holder, interior door handles, window regulators and rear compartment ash tray

*Fisher Body—Ternstedt Division

Little touches tell a lot about the superior craftsmanship that characterizes the new Body by Fisher. In the appointments illustrated here, you see reflected the care and artistry that make fine coachcraft even finer.

Here are interior notes to match this body's outward smartness and beauty — to complete the advanced styling of the 1946 Body by Fisher.

Such touches add extra value to the extra comfort and safety Body by Fisher provides — added features that are the result of 38 years' experience in making a specialty of fine coachcraft. Look for the Body by Fisher emblem before you decide which car to buy.

Body by Fisher

BETTER BY FAR

Thousands of dollars in university scholarships and cash awards for best miniature Napoleonic coaches or model cars submitted by boys of 12-19 years inclusive. For information, write: Fisher Body Craftsman's Guild, General Motors Bldg., Detroit 2, Michigan.

You get Body by Fisher
only
on General Motors cars

CHEVROLET • PONTIAC
OLDSMOBILE • BUICK
CADILLAC

The New 1946 Pontiac Streamliner 4-door Sedan

There's a "Four" for YOU—

—just right in size, power, performance . . . in Evinrude's complete line of 4 thrilling four-cylinder models!

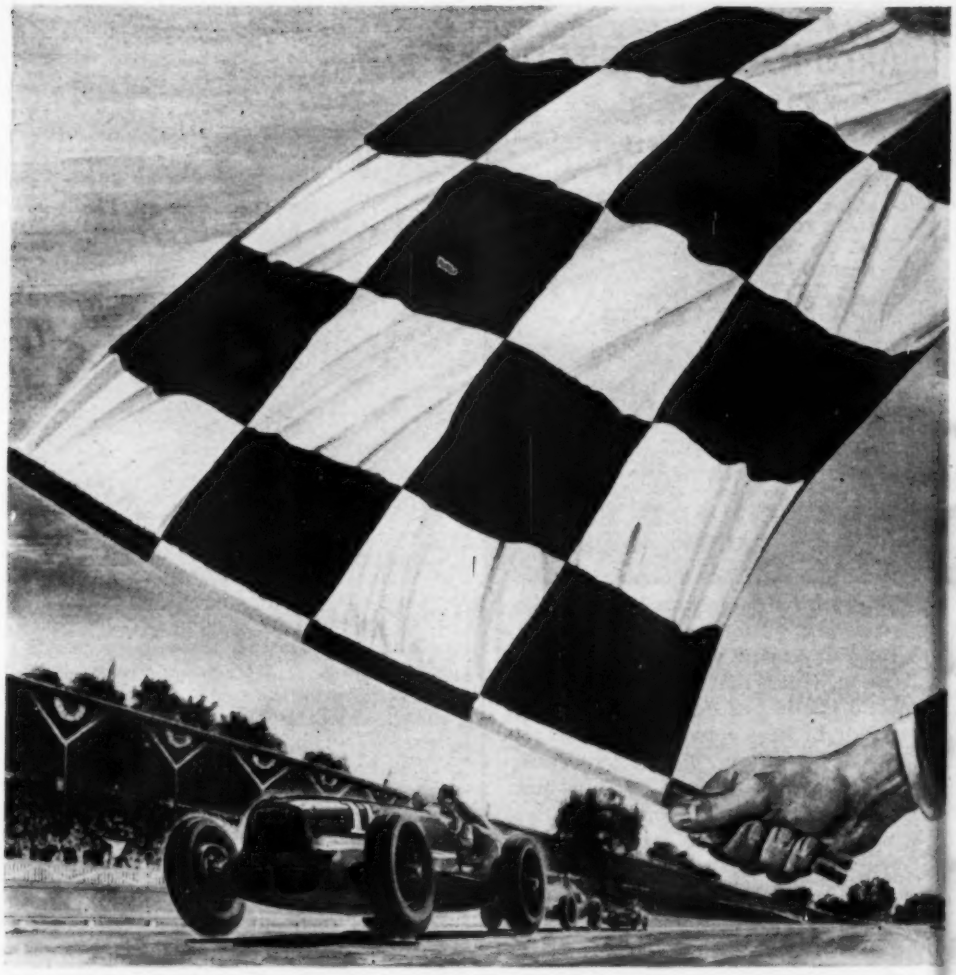
If you want a motor developing 5 horsepower or more — why not enjoy the *extra* smoothness — the *extra* thrill of performance — *that are yours with an Evinrude "four"?*

There's nothing like them — for any boat, or any kind of service! No other type of outboard motor to match their velvety surge of power, their responsiveness and flashing get away!

See your Evinrude dealer—look for his name under "Outboard Motors" in your classified telephone directory. Catalog of the complete Evinrude line of 8 models sent on request. Write for it today — address, EVINRUDE MOTORS, 5361 N. 27th St., Milwaukee 9, Wis.

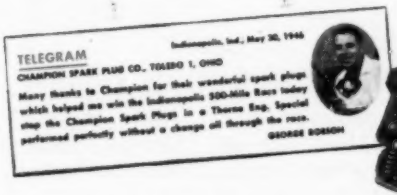
EVINRUDE
OUTBOARD MOTORS

In Canada: Evinrude Motors, Peterboro, Ontario.



GEORGE ROBSON *wins Indianapolis Race with* *dependable*

CHAMPION SPARK PLUGS



TELEGRAM

Indianapolis, Ind., May 30, 1946

CHAMPION SPARK PLUG CO., TOLEDO 1, OHIO

Many thanks to Champion for their wonderful spark plugs which helped me win the Indianapolis 500-Mile Race today stop the Champion Spark Plugs in a Thorne Eng. Special performed perfectly without a change all through the race.

GEORGE ROBSON

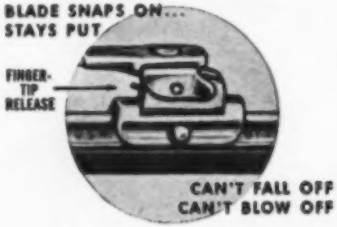
Once again Champions were proved Champions in fact as well as in name in the 1946 Indianapolis Race. Dependable Champion Spark Plugs equipped the winning car, the first six to finish, and nine of the ten money winners. In the last 19 races, eighteen winners and 177 out of 190 cars finishing in the money were Champion equipped—irrefutable evidence that Champions are the choice of experts.

FOLLOW THE EXPERTS . . . DEMAND DEPENDABLE **CHAMPIONS** FOR YOUR CAR

ANCO RAIN-MASTER

"Dead-Locker"

WINDSHIELD WIPER ARMS and BLADES



(A war-born invention—by ANCO—first for military aircraft—now for your car.)

DON'T SHOOT YOUR GAS-PUMP MAN!

He's doing the best he can. Sure, he knows how dangerous it is for you to drive your car . . . in stormy weather . . . with your dull old windshield wipers that smear and smear. He'd gladly put on for you quickly a pair of keen new ANCO RAIN-MASTER Wiper Blades and Arms. He has them—Newest Models! But he forgets to remind you? Too busy? You can't shoot him for that!

After all, it's *your* car to protect. So *you* remind *him*. Get RAIN-MASTERS . . . patented features . . . original equipment on many makes of high grade cars and trucks . . . used in war—on our fighting tanks and trucks and ships and bombers too...because ANCO RAIN-MASTERS clean quicker, clean cleaner . . . last longer. May save you a costly smashup.

Ask for RAIN-MASTER Windshield Wiper Arms and Blades next time you buy gas.

THE ANDERSON COMPANY
Established 1918
GARY, INDIANA

Charcoal Broiler a Picnic Aid

CONSTRUCTED to fold up with its fuel inside for easy carrying, this portable charcoal broiler has been devised for picnics and camping. A grate holds steaks, chops or fish between the two walls, which contain the charcoal. They can be adjusted for desired cooking speed and temperature. Coffee and vegetables can be cooked at the same time on the heating plate above the broiler unit. It is manufactured by the Given Company, of St. Paul, Minn.

Full Vision with Plastic Goggle

THE Sporti-Goggle, of clear or green plastic, curves over the entire eye cavity to keep wind, glare, and dust from interfering with vision. Weighing only two ounces, the goggle fits over regular glasses.

WHAT TO DO IF LOST IN THE WOODS AT NIGHT

Common sense and your flashlight can bring you through, says Adirondack guide Edwin Young, of Star Lake, N. Y.

1 First—take it *easy!* You're never really *lost* until you lose your head! *Don't travel at night.* Instead, use your flashlight to gather boughs and leaves for a bed, near a stream if possible. Build a signal fire; it will warm you and protect you. Then—

2 Flash the S.O.S. signal with your flashlight—three short, three long, three short—to guide searchers. Long-lasting "Eveready" batteries will send *hundreds* of such brilliant, penetrating light signals. Save your strength for daylight. Then—

3 Stay where you are until help comes. But, if you *must* travel, put out fire, head *downstream* along *any* running water; it will generally lead you to safety. When out of the woods, resolve: To *always* carry matches in a waterproof case, a compass, and an "Eveready" flashlight on *every* outing!

For

EXTRA POWER, EXTRA LIFE —AT NO EXTRA COST

4 When you need a flashlight for emergency use—in the woods, at home, in your car, you *need* it! That's why it's wise not to compromise with anything less than "Eveready" batteries. Their longer life of brighter light has justly made them the *largest-selling flashlight batteries in the world.*

NATIONAL CARBON COMPANY, INC.
30 East 42nd Street, New York 17, N. Y.
Unit of Union Carbide and Carbon Corporation
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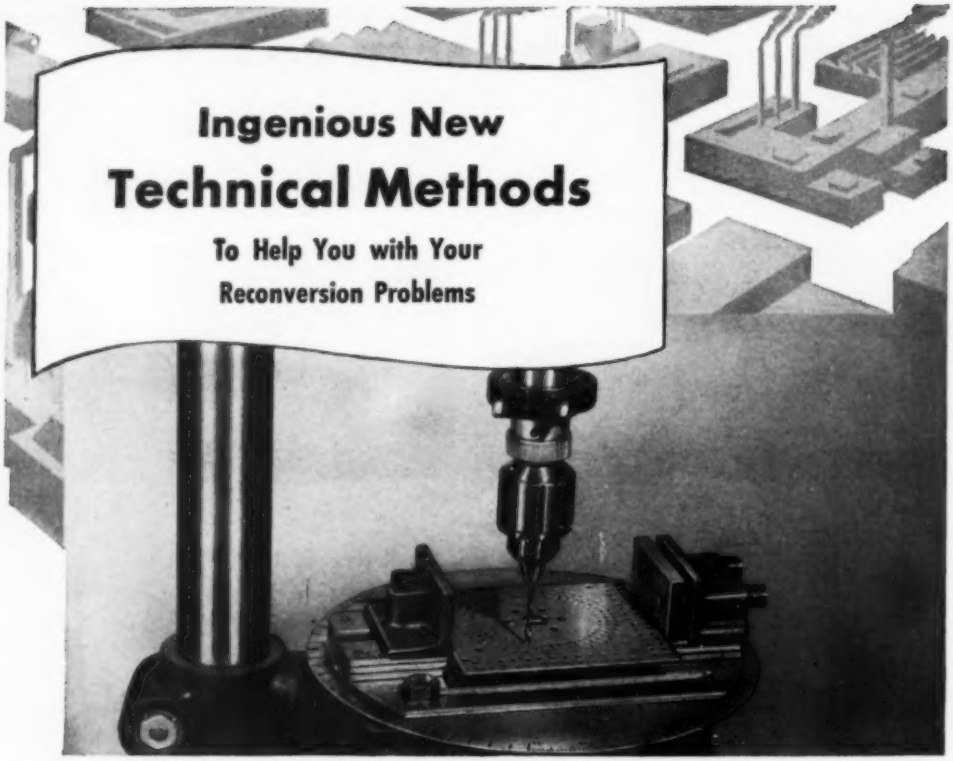
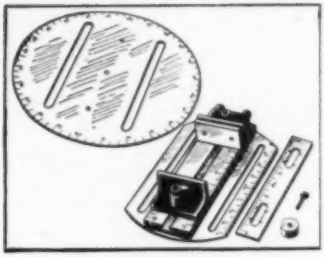
EVEREADY
TRADE-MARK

The registered trade-mark "Eveready" distinguishes products of National Carbon Company, Inc.



New, Simplified, Drill Press Vise, Speeds Up Drilling, Spacing, Milling



Designed to be used with a drill press table having either parallel or radial slots, the New UNI-VISE drill press vise, with guide bar and protractor disc, speeds up and simplifies drilling, layout and spacing work in straight lines, radial or circular. With two movable jaws, vise has universal movement without swinging table or head of drill press to locate exact position of work. Operator thus adjusts work quickly for accurate registration.

Guide Bar facilitates drilling holes in a straight line. With a straight edge and a lineal scale on surface, it registers with lineal scale of vise. Protractor disc, for drilling holes accurately in a circle, has parallel slots registering with parallel slots in base of vise, and a removable means to pivot complete unit on table of drill press.

Accurate work can always best be done by attentive operators. That's why many factories urge workers to chew gum. The chewing action helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety. And workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy.

You can get complete information from Spiral Mfg. Corp. 3612-26 N. Kilbourn Avenue, Chicago 41, Ill.

AA-87

Ford's out Front

WITH THE ONLY V-8 ENGINE IN THE LOW-PRICED FIELD!

America's costliest cars have V-type engines. Only Ford has it in the low-priced field!

The only 100 h.p. engine in its class...the champion performer!

New 4-ring aluminum pistons save ye a pur-r-ty penny on gas and oil!

V-8's extra smoothness comes from overlapping power strokes!

V-8 makes fewer turns per mile...the car "hustles" while the engine "loafs." That means longer life!

Look! Only Ford production magic brings you this finest type engine at lowest cost!

THERE'S A Ford IN YOUR FUTURE!

* Out in California, Frank Hegemeyer has made a profitable full-time job out of his life-long hobby – hand-made reproductions of Early American and Colonial furniture.

IT'S A HOBBY—IT'S A BUSINESS!

IT'S A PLEASURE WITH X-ACTO!

*AND in his work he finds X-acto hobby knives "of untold value". With the help of X-acto, Mr. Hegemeyer has filled his home with beautiful furniture . . . created material for his fascinating how-to-do-it articles . . . and had a whale of a lot of fun!

Expert Hegemeyer has high praise for the way X-acto blades "hold a keen cutting edge over a long period . . . and their adaptability to the many types of cutting jobs encountered in my shop." No wonder! For X-acto gives you

13 Blade Shapes—Quickly Interchangeable...

of fine surgical steel, scalpel-sharp. *Three all-metal handle styles.* (No more substitute plastics!) X-acto's safety grip and easy control make it the ideal knife for experts *and* beginners . . . for paper, leather, wood, plastics. If you build models, whittle, carve, or just fix things around the house, you'll turn out better jobs with X-acto. And have *more fun!*

ALL METAL
X-acto No. 2 Solid Duraluminum Knife . . . **50c**
With 5 assorted blades, $1. Other X-acto Knives, Tools, Chests, 50c to $12.50.

It's Got Everything! No. 85 X-acto Tool Chest – 3 all-metal knives; full assortment of blades; saw; sander; stripper; planer; drills and holders; steel ruler; complete in wooden chest, $12.50.

X-acto*
KNIVES & TOOLS
At hardware, hobby and gift shops

X-acto Crescent Products Co., Inc., 440 Fourth Ave., New York 16, N.Y.
In Canada: Handicraft Tools, Ltd., Hermant Bldg., Toronto

**Reg. U. S. Pat. Off.*

look SHARP

You look **SHARP** because you get the best-looking shaves any man ever had!

feel SHARP

You feel **SHARP** because Gillette Blue Blades give you the quickest, most refreshing shaves of your life!

be SHARP

You are **SHARP** when you buy Gillette Blue Blades with the **SHARPEST** edges ever honed, because you get more shaves per blade and save money!

use Gillette Blue Blades

5 for 25¢

with the **SHARPEST** edges ever honed!

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GILLETTE'S CAVALCADE OF SPORTS presents the major boxing event of the week every Friday night over American Broadcasting Company stations coast to coast

Gillette Safety Razor Company, Boston 6, Mass.

1 SCREW DRIVER does the work of 3

MILLERS FALLS *Automatics can handle any job*

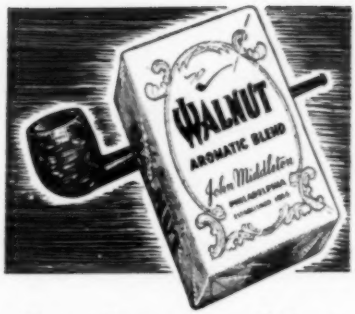
With only one screw driver—the Millers Falls Spiral Ratchet—you can do *any* screw driving job quickly and easily. It can be used as a regular rigid screw driver, a right or left hand ratchet, or as a complete automatic. Changes are made simply by shifting the knurled control sleeve and the spiral lock nut.

Smooth, powerful action and tested dependability are built into Millers Falls Automatic Screw Drivers. They will give you long-lasting satisfaction in your home workshop or light production assembling. Ask your dealer to show you these fine Millers Falls tools.

One Thing in Common—QUALITY!

MILLERS FALLS TOOLS SINCE 1868

MILLERS FALLS COMPANY
GREENFIELD, MASSACHUSETTS



Complimentary Offer!

We know of no better way to convince you of the fine smoking qualities of Walnut Pipe Tobacco than to send you a free sample packet, together with our booklet, "The Choice of Experience," which tells the fascinating history of Walnut—America's largest selling high grade pipe tobacco. A postal card request will do. John Middleton, 1203 Walnut Street, Philadelphia 7, Pa.

JOHN MIDDLETON
Fine Tobaccos Since 1856

Good Living!

A MOBILE HOME • AT MODEST COST

● You can take a Schult Luxury Liner wherever you need it, for living or playing. In it you have every facility of a 2-bedroom house, plus insulation and a heating plant for year-round comfort.

LUXURIOUSLY FURNISHED

Regular double bed built into bedroom; sofa-bed in living room converts into *extra* double bed. (Sliding doors provide 3-room privacy.) Complete kitchen includes oven range, double sink, refrigerator and ample food storage space. 3 wardrobes, plenty of drawers and closets for clothes, etc.

See these trailer coaches at your Schult dealer, or send for catalog featuring 1946 Schult Luxury Liner.

SCHULT CORPORATION, Dept. 3109, ELKHART, INDIANA
MEMBER: TRAILER COACH MFG. ASSN.
In Canada, John Inglis Co., Toronto

SCHULT *Trailer Coaches*

SMOOTH HORSEPOWER

CASITE GUARANTEES BETTER AND SMOOTHER PERFORMANCE OR *DOUBLE-YOUR-MONEY-BACK*

★ New or old—your car will run better and last longer with Casite. Casite protects stiff new motors during the critical break-in period . . . gives older motors new smoothness, pick-up and power.

Casite carries oil quickly to the tight spots . . . reduces engine wear . . . retards formation of sludge and gum . . . *cleans motors—keeps them clean.*

Millions of motorists use Casite all the time. Service stations, garages and car dealers everywhere sell it.

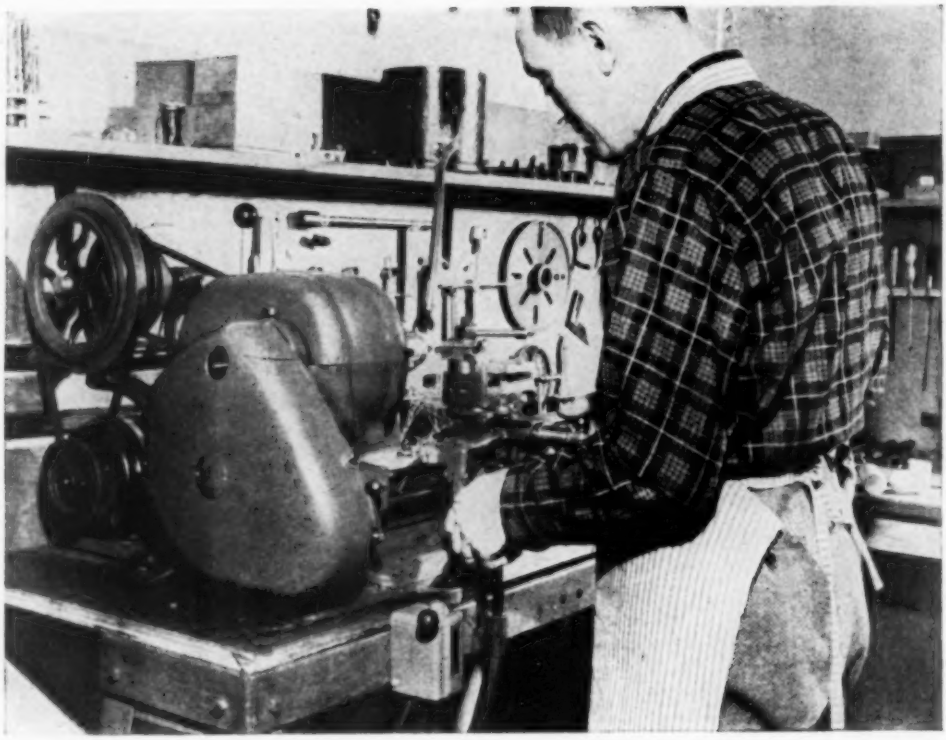
Put a pint in the crankcase every oil change and a pint through the air intake every three months for *guaranteed* better and smoother performance all-year-round.

THE CASITE CORPORATION, HASTINGS, MICHIGAN • In Canada: Hastings Ltd., Toronto

NEW RADIO SHOW: "RIGHT DOWN YOUR ALLEY"
AMERICAN BROADCASTING CO. • EVERY SUNDAY AFTERNOON

GUARANTEE

Add Casite to crankcase and run through air intake according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double-your-money-back by filling out guarantee certificate and mailing it to The Casite Corporation, Hastings, Michigan. Maximum refund is $1.30 per pint, twice the nationally advertised price of Casite.



YOU, *INCORPORATED*

A world of almost limitless opportunities for pleasure and profit opens up for you when you own an Atlas lathe.

Hundreds of useful things of metal, wood, or plastic can be made for your home — and home equipment repaired. Valuable tools can be made to add to your shop facilities. And if you have the time and interest you can do special production work — as does H. C. Rapp, above — for extra shop profits.

Whatever project you undertake, an Atlas will help you make the most of your mechanical skill. It gives you the precision needed for delicate operations — the strength required for heavy cuts. It gives you a wide selection of speeds and feeds — and complete versatility in all the fundamental lathe machining operations. Yet it will come to you — at an exceptionally low price.

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Get complete information about Atlas lathes, drill presses, millers, shapers, and the many inexpensive accessories available for Atlas tools. Send for this free catalog today. Atlas Press Co., 955 North Pitcher Street, Kalamazoo 13D, Michigan.

Atlas 4 TOOL TEAM

AMAZING NEW BATTERY—*Needs water only 3 times a year...*

IN NORMAL CAR USE

Lasts longer, too!

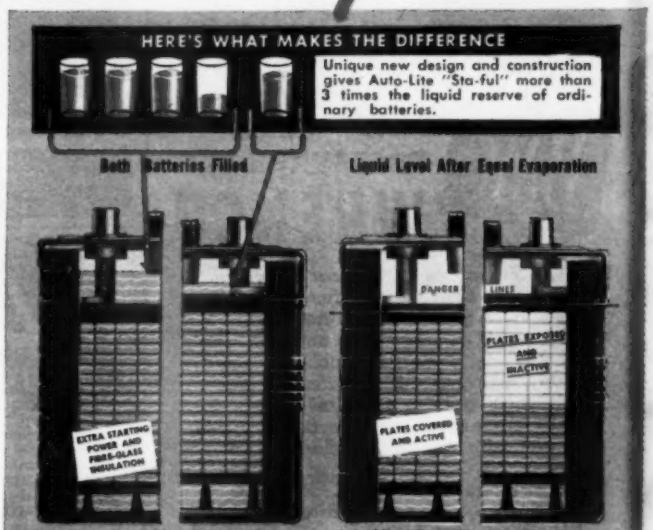
The Auto-Lite "Sta-ful" Battery has more than 3 times the liquid reserve of ordinary batteries. In normal car use the plates are kept submerged to help deliver full life and power long after the plates in ordinary batteries are exposed and inactive.

In addition, oversize electrical capacity, plus Fibre-glass insulation, gives longer life than batteries without the Auto-Lite "Sta-ful" features.

Be sure your next battery is an Auto-Lite "Sta-ful."

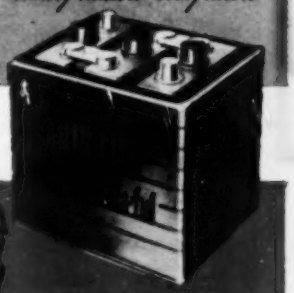
AUTO-LITE BATTERY CORPORATION
TOLEDO 1 OHIO

Manufacturing Plants at:
Niagara Falls • Indianapolis • Atlanta
Oakland • Oklahoma City • Toronto



Illustrations above show the result of equal evaporation in the Auto-Lite "Sta-ful" Battery and other batteries. As shown by illustration on the far right, plates of ordinary batteries are exposed sooner by water loss and then become inactive faster.

For sale by Auto-Lite battery dealers everywhere



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AUTO-LITE

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- ADJUSTABLE END WRENCH
- PIPE WRENCH
- GRIPPING TOOL
- MULTI-LEVERAGE PLIERS
- HAND VISE
- CLAMP

All COMBINED in *One*

BMC PRESSURE-LOCK WRENCH

Here is the tool you've been waiting for, a tool that combines six principal uses in one unit. It gives tight, slip-free grip, with easy thumb adjustment, on any piece you can get hold of—nuts, studs, pipe, short, broken or irregular pieces. Patented parallel jaws apply gripping power uniformly over entire jaw surface—right to the very tip. Locked with one hand; released with a flick of the finger—it's a true *one hand* wrench—regardless of size. Hundreds of uses in shop, garage, home or on the farm. It's a revelation!

Now Available . . .

A *Husky* Addition

to the BMC family, the NEW No. 11 Pressure Lock Wrench — large, powerful, designed for heavy duty — is 11" long, has 1½" maximum jaw opening, and a 1½ ton grip!

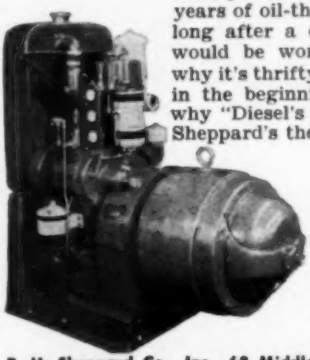
On sale at leading hardware, auto equipment, electrical and mill supply stores. Three sizes:

No. 7—Max. jaw opening ¾"—$2.45
No. 9—Max. jaw opening 1 "—$2.95
No. 11—Max. jaw opening 1½"—(to be announced)

BMC MANUFACTURING CORP.
Binghamton, N. Y.

Pay More and be thrifty!

A Sheppard Diesel may cost slightly more than an ordinary engine. But, it will soon save enough on fuel bills to pay the difference—because it uses common *domestic furnace oil.* After that, you are all set to enjoy years of oil-thrifty power . . . long after a cheaper engine would be worn out. That's why it's thrifty to spend more in the beginning . . . that's why "Diesel's the Power . . . Sheppard's the Diesel".



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2,000 to 36,000 Watts

Power Units
3¾ to 56 Continuous H.P.

Marine Engines
3¾ to 62 Continuous H.P.

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DIESEL'S THE POWER—**Sheppard's** THE DIESEL!

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CATALOG and HANDBOOK

FUN AND PROFIT AHEAD

Plastics, colorful and glamorous materials of the future, offer you a fascinating hobby — or a profitable plastics fabricating business of your own.

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The new Carmen-Bronson PLASTICS HANDBOOK tells how to fabricate plastics easily and simply into beautiful objects for gift or sale. Contains construction plans for many simple and advanced projects. Profusely illustrated. Gives practical advice on how to start your business in this profitable field.

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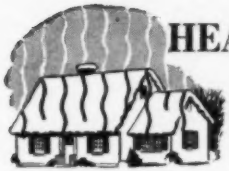
165 East 3rd Street, Dept. 9-A Mount Vernon, N. Y.

The ABC of MODUFLOW*



HEAT LOSS is continuous, but the rate of loss varies with the weather. When it is cold heat loss is more rapid than when the weather is warmer.

HEAT SUPPLY should also be continuous, but modulated

to whatever temperature is required to offset the heat loss.

MODUFLOW · · · maintains a continuous balance between heat loss and heat supply.

RESULT · · · "Comfort Unlimited"

FOR YOUR PRESENT HOME... You, too, can have the "comfort unlimited" that Moduflow has brought to thousands of homes. You don't have to wait until you build a new home. Moduflow can be easily and inexpensively installed on practically any type of automatic heating plant.

FOR YOUR NEW HOME... Of course, if you are planning to build, you will want your heating plant to be efficient and the last word in heating comfort. There isn't room to explain here just how Moduflow can be applied to the various types of heating systems, whether warm air, hot water or steam. It is completely described in the booklet "Comfort Unlimited" which has just been released. Attractively illustrated with pictures and diagrams, it will be especially interesting to readers of *Popular Science*. So, mail the coupon today for your free copy of "Comfort Unlimited."

* MODUFLOW is the name of Honeywell's newest heating control system. It means *modulated* heat with continuous *flow*. Moduflow will be a "must" in the better homes and apartments of tomorrow.

MODUFLOW

The New HONEYWELL Heating Control System

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2767 Fourth Avenue South
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Please send my free copy of "Comfort Unlimited"

FREE!

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New or old, keep your car good-looking always by SIMONIZING it now! If the finish is already dull, an easy "once over" with Simoniz Kleener restores beauty immediately. Then SIMONIZ keeps your car ever beautiful and easier to clean with a dry cloth. Get SIMONIZ and Simoniz Kleener, liquid or paste, today!

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WITH A PALMGREN

MILLING ATTACHMENT

Convert Lathe in 10 Seconds

Now—you can do milling, slotting, grinding, grooving, squaring shafts, sawing at angles, and many other important operations on your lathe. PALMGREN MILLING ATTACHMENT is a necessary fixture for small shops, schools and emergency work in large plants. Fits South Bend, Atlas, Craftsman, Logan, Sheldon and all other makes. It has graduation for rotary angle adjustments, also graduated feed and adjustment screw. Easily mounted by straddling lathe's regular tool post. Try one—it will quickly pay for itself.

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No.	Width Jaws	Depth Jaws	Jaws Open	Weight Pounds	Base Opening	Price F.O.B. Factory
150	1½"	1"	1½"	6½	1"	$18.75
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400	4"	2½	4"	25	2"	39.75

Order from your dealer or jobber. Write for circular No. 349

CHICAGO TOOL AND ENGINEERING CO.

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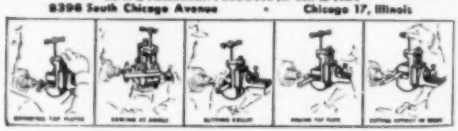

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Many small parts can be formed without dies, to duplicated accuracy of .001" with DI-ACRO Precision Machines. — Benders, Brakes, Shears. Save die expense and time delay. Ideal for experimental and research work, making samples, models, etc. as well as regular production runs. Write for descriptive literature.

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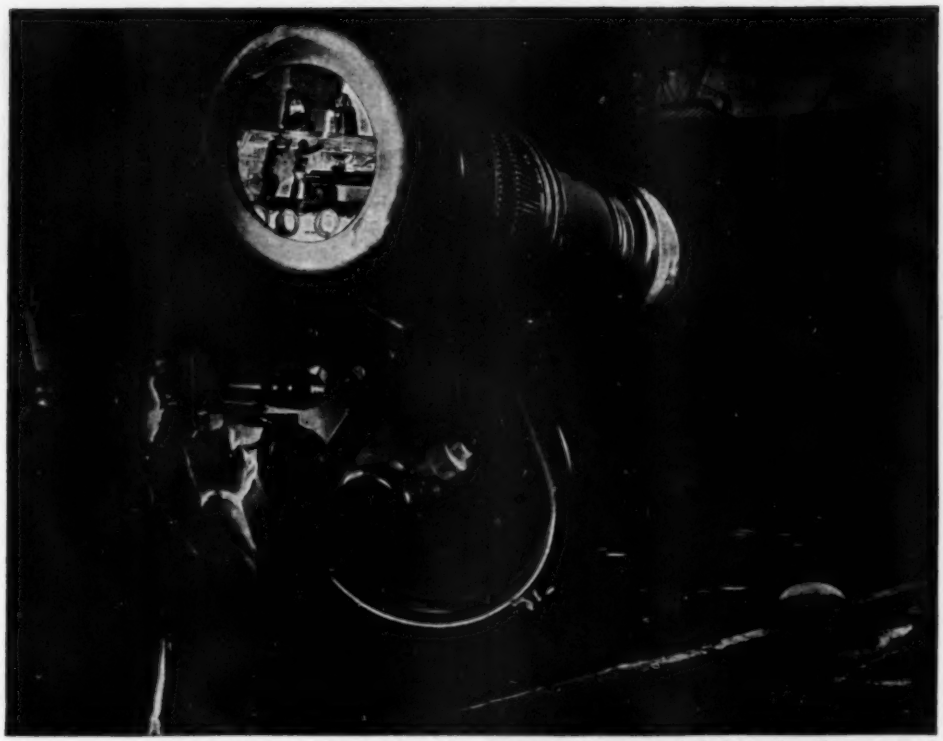
A PULVEX QUALITY DOG PRODUCT



Robbery at the waterfront—detected and observed in total darkness through the infrared ray "snooperscope."

"Snooperscope"--sees at night with invisible light!

Crime detection is one of the many uses for this uncanny telescope that can distinguish objects a quarter of a mile away in a complete blackout.

The sniperscope and snooperscope are two wartime developments of RCA Laboratories in co-operation with the U. S. Army which are now being converted to civilian uses.

These instruments were made possible through a tiny image tube less than two inches in diameter and less than five inches long. Adapted to various military equipment, these telescopes provided the Army with some of its best night-fighting devices. A helmet-mounted binocular, employing these image tubes, enabled scout cars to speed over roads at 40 to 50 miles an hour without lights.

The same imagination, planning and engineering skill that produced the snooperscope are reflected in every RCA and RCA Victor product. If it's an RCA, it is one of the finest instruments of its kind science has achieved.

Radio Corporation of America, RCA Building, Radio City, New York 20. Listen to The RCA Victor Show, Sundays, 2:00 P. M., Eastern Daylight Time, over the NBC Network.

The "Sniperscope." Here our infrared telescope is mounted on a carbine. The combination was aptly called a "sniperscope" for it enabled a soldier in total darkness to hit a target the size of a man at 75 yards. Thirty percent of the Japanese casualties during the first three weeks of the Okinawa campaign were attributed to the sniperscope.

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Simple, easy instructions how to take beautiful pictures outdoors regardless of position or brilliance of sun. Learn now how to take master shots in shade or even on stormy, rainy days. No expensive, complicated equipment or special knowledge or experience required.

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Without obligation on my part, please send free booklet, "Synchro-Sunlight".

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For a Beautiful Lawn NOW and NEXT SPRING Apply WEED-NO-MORE NOW

KILLS WEEDS OR YOUR MONEY BACK*

$1 ***Rids Your Lawn of Weeds***

8 OUNCES MAKE 8 GALLONS, enough for the average lawn. The $2.98 Quart Economy Size makes 32 gallons.

Here's the simple, sure way to banish those scraggy, ugly weeds that make your lawn look pock-marked and unkempt. Just dilute Weed-No-More with water, spray it on, and weeds disappear. When applied according to directions, common lawn grasses are not harmed, soil is not injured.

**Use according to directions on package. Allow at least three weeks for killing action. If not satisfied that Weed-No-More kills weeds, send package to the manufacturer, and full purchase price will be refunded.*

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SOLID! Every model precision-cast in solid metal for greatest perfection of detail! Gun turrets, nacelles, rudders, reproduced with mathematical accuracy. 93 planes of 7 nations, beautifully finished. Scale: 1 in. to 36 ft.

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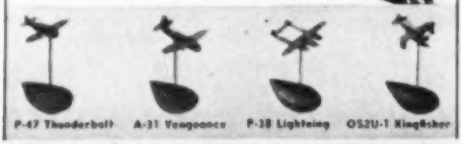

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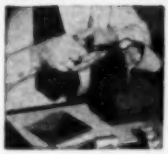

is again available in limited quantity without priority. Orders filled in sequence as received. INVENTORS-SCHOOLS-CRAFTSMEN use POUNDRYETTE for making castings quickly for new inventions, for instruction, and general purpose. Order now for early delivery. Three sizes are available capable of making bronze castings of 1½, 3, and 6 pounds weight, aluminum, copper, brass, etc. $17.50, $24.00, $34.50, f.o.b. Kansas City. Domestic gas supply and 110 volt AC or DC energy required for operation. Write for circular

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Two Bruno Adjustable Hole Cutters in one convenient kit for home users, mechanics, farmers, technicians! High speed steel blade cuts clean, fast holes in metal, wood, plastics. Quickly adjustable and easily sharpened. For drill press, portable drill or hand brace. **Money back guarantee!**

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MODEL	SHANK SIZE	EXPANSION	PRICE
100	1/4" st. shank	5/8"—1 1/2"	$3.00
101	3/8" st. shank	1"—2 1/2"	$5.00
790 KIT		5/8"—2 1/2"	$8.00*

*Fair Trade Minimum $7.85

At all hardware stores or write direct, Dept. PS-9

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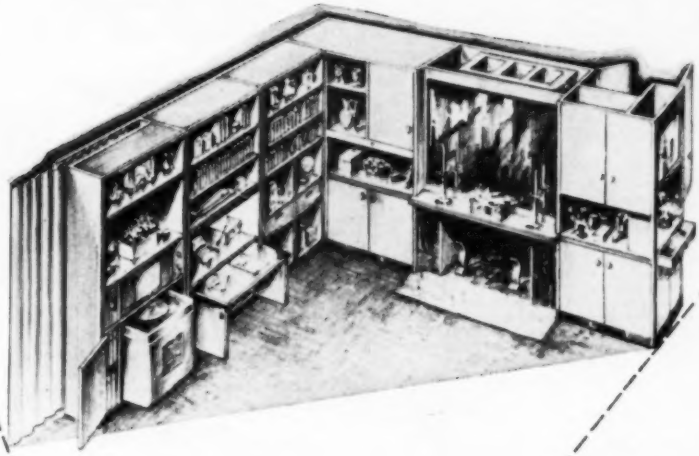
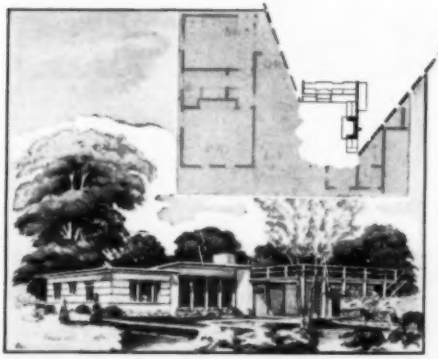
A NEW ANGLE ON

BETTER LIVING



BETTER to live in, easier to keep in "shipshape" order—that's modern home-making with Defoe's "Working Walls". And Defoe will literally put your walls to work with expertly designed, built-in storage and utility units in addition to closets and wardrobes. ✓ The "Working Wall" illustrated here, for example, is one living room unit combining a heat-circulating fireplace with book cases, writing desk, radio-phonograph and plenty of storage space for your record albums, card tables and other accessories for home enjoyment. ✓ Send in the coupon today for your copy of the illustrated brochure which describes and illustrates other "Working Wall" units. It will also bring you architect's drawings of homes which can be built by Defoe's distinctive method of home construction.



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Defoe HOMES

HOUSING DIVISION
DEFOE SHIPBUILDING CO., Dept. PS-9
BAY CITY, MICHIGAN

Please send me the descriptive brochure on the new Defoe Homes. Enclosed is 10c for handling and mailing costs.

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The New Remarkable Martin Outboard Motor gives you everything you'd expect in a fine outboard . . . *PLUS* many exclusive features!

The new MARTIN "60" Outboard Motor is a sensational alternate firing twin, with full reverse PLUS an amazing combination of extra features, to be found ONLY in the new MARTIN "60":

Mechanically Controlled Poppet Valves give MARTIN operators mile-an-hour trolling . . . or top speed cruising!

Unusual Horsepower. More than one horsepower for each 6 lbs. of motor wt. (Wt. only 42 lbs.—MARTIN develops *7.2 H.P.!*)

Easy Grip Clamp Screw Handles Easily reached and operated . . . easy to grasp.

Durable Baked Enamel Finish and special aluminum lacquer insure added life and beauty . . . prevent corrosion.

3 Resting Positions. "Ears" at 4 corners give motor 3 resting positions . . . PLUS added protection, easy packing!

Hollow Drive Shaft gives lightness plus strength where it's most needed.

New Manifold insures virtually flood-proof starting.

Exclusive Patented Full Swivel facilitates checking lower unit without reaching into the water. ENTIRE MOTOR MAY BE TURNED END-FOR-END! For roomier boating, motor may be left in crosswise position and tilted backward out of boat.

Exclusive Combined Filler Cap, Air Vent and Spare Shear Pin Clip. Can't come loose, can't rattle. Opened effortlessly. Under side holds two spare shear pins. Built in, leak-proof air vent.

MARTIN Vertical Stern Adjustment—a few turns of the knob to achieve correct vertical motor position. Adjustment can be made *while boat is under way!*

It's the motor that has everything . . . *PLUS*

OUTBOARD MOTORS

MARTIN MOTORS, Eau Claire, Wis.
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IT'S EASY TO MAKE YOUR OWN "BLOW-UPS"

And grand fun too, with a FEDERAL "America's Fastest Selling Enlarger"

Picture-taking's a pleasure, but the real thrill comes when you make your own enlargements. It's really *easy* to turn out top-notch prints, and *inexpensive*, too, when you use a Federal.

Advanced principles of illumination and optics make this the finest Federal ever built. And for *extra value*—a tested, anastigmat lens is included in the modest price of every Federal.

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Amazing Postwar Development Now Gives You the Opportunity to Make Money Fast!

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Plastics, one of the most revolutionizing and rapidly expanding industries, offers a great opportunity to all enterprising **men** and **women.** This is one of the few industries in which home manufacturers thrive and prosper. You can start even on a spare time basis in your own home, and expand rapidly into a full time business, paying good profits.

LIQUID MARBLE

Make LIQUID MARBLE the amazing Plastic, with a thousand uses. LIQUID MARBLE can be poured into FLEXIBLE MOLDS for casting all kinds of artistic and serviceable articles such as: ornaments, novelties, desk sets, paper weights, book-ends, souvenirs, statuary, toys, etc.

FLEXIBLE MOLDS

Make your own FLEXIBLE MOLDS. The cost is low—in fact, a large sized mold costs but a few cents. Hundreds of casts can be taken from a single mold.

NO EXPERIENCE NEEDED!

No skill or previous knowledge is necessary. All you do is follow our easy-to-understand instructions.

UNLIMITED MARKET

The market is literally unlimited. You will find steady year-round demand in your own community. Your problem will not be in Selling but in supplying the huge pent-up demand. Moreover, we supply you with names of **big buyers** for your finished products.

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Bing Products will show you how to start with a small investment and build a permanent, independent, profitable business! Don't fail to grasp this opportunity! Write today for FREE CATALOG.

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He's sick and tired of long, tedious trips on the road. He wants no more of lonely nights in hard-to-get hotel rooms away from his wife and children. *Now* he can travel in luxurious comfort and return home each night. *He flies Aeronca!*

Yes, Aeronca has brought America a new way of life. To learn the pleasure, the economy, the utter simplicity of flying Aeronca . . . visit your Aeronca dealer soon. And remember—when you *buy Aeronca* he'll teach you to *fly Aeronca*—FREE! Aeronca Aircraft Corporation, Middletown, Ohio.

HOME AGAIN, RELAXED, REFRESHED in the luxurious new Aeronca Chief. With handy starter and 34 other extra-value features, it's one of the world's easiest planes to fly! Cruises at 90 mph . . . lands at 38 mph . . . with cruising range of 420 miles.

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AERONCA *America's No. 1 Low Cost Plane*

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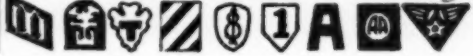

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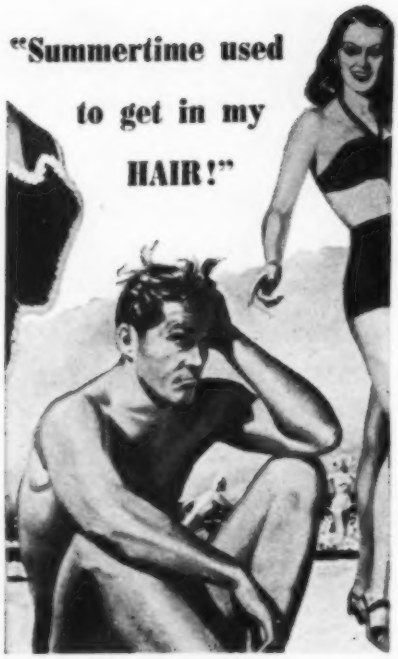

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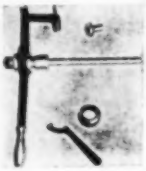

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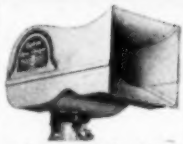

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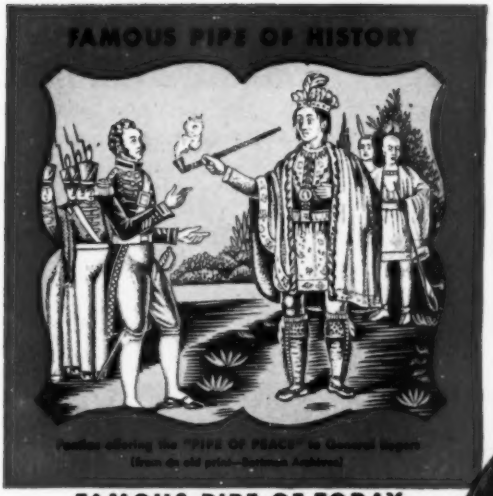

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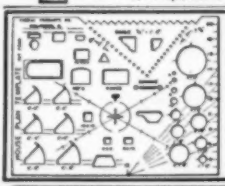

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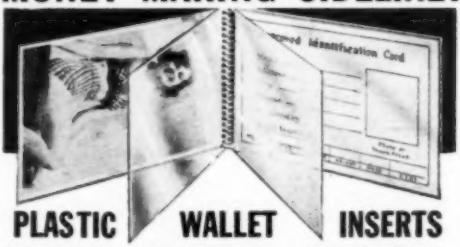

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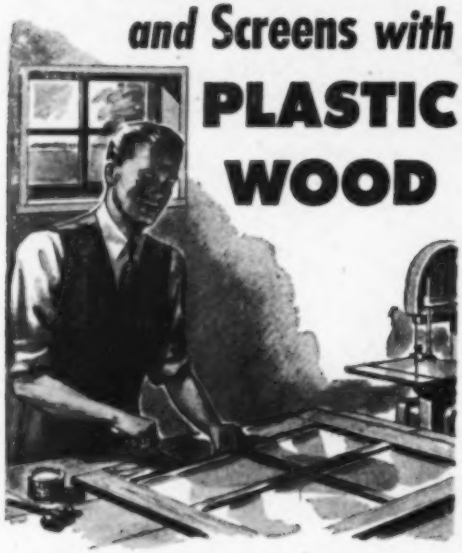

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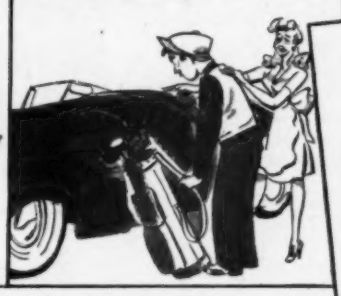

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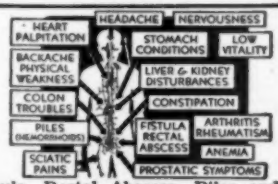

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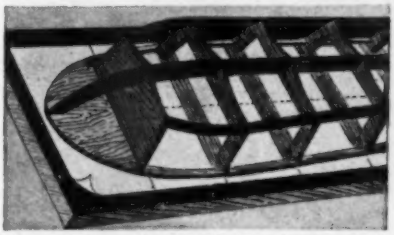

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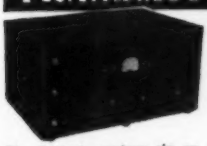

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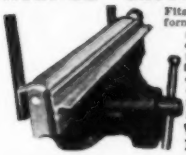

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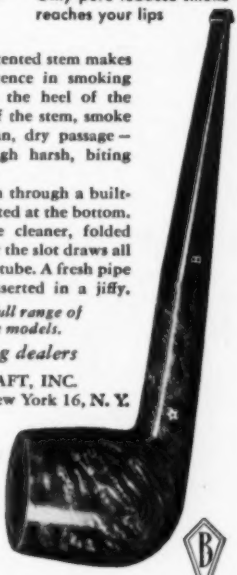

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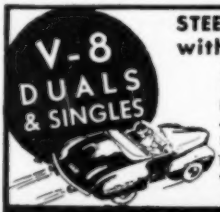

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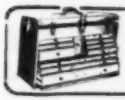

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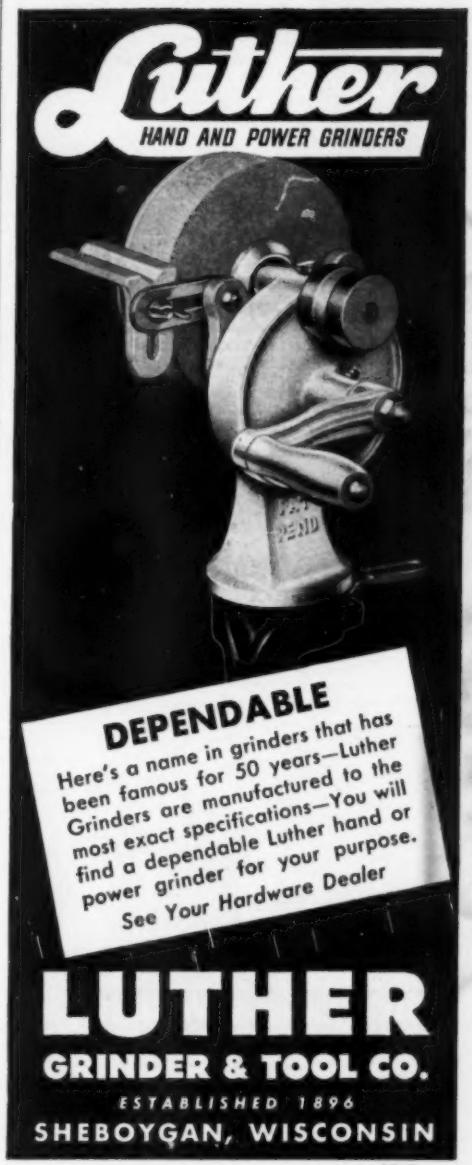

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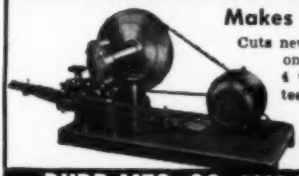

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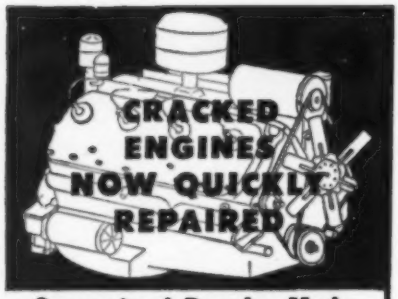
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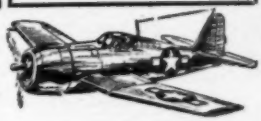

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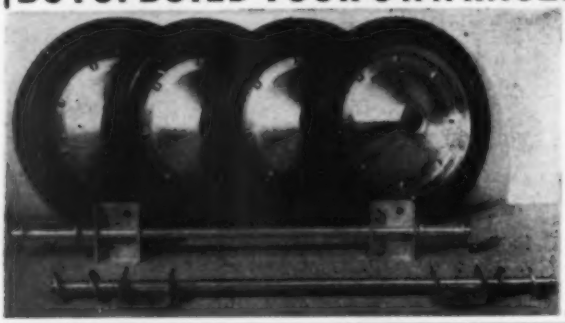

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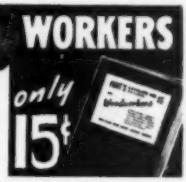

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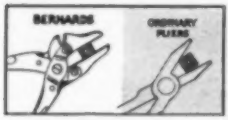

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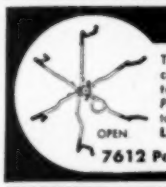

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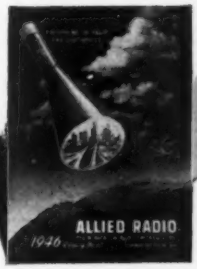

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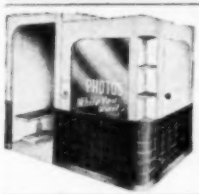

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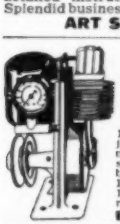

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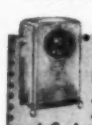

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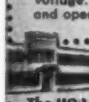

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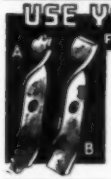

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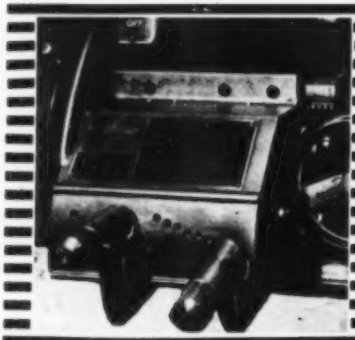

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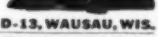

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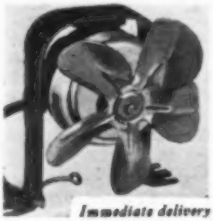

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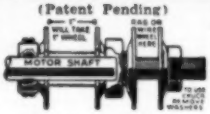

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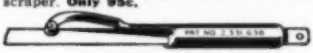

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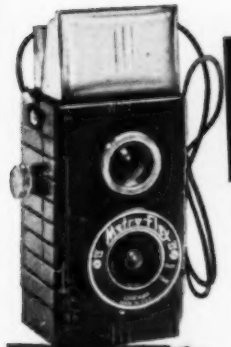

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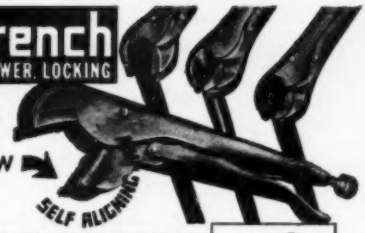

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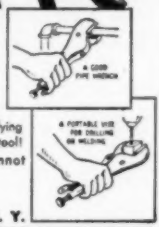

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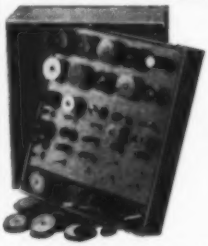

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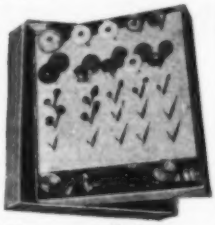

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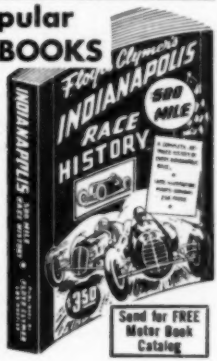

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Which General Article did you like best? (Please name only one.)

(Questionnaire continued on back of this sheet)

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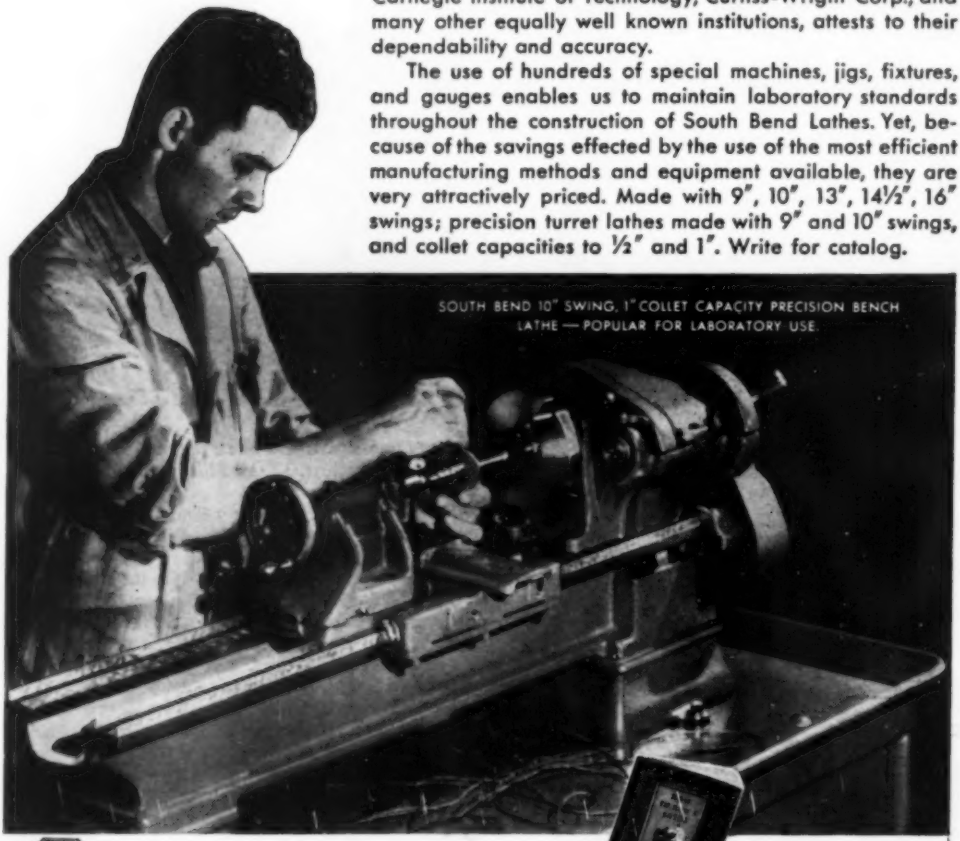

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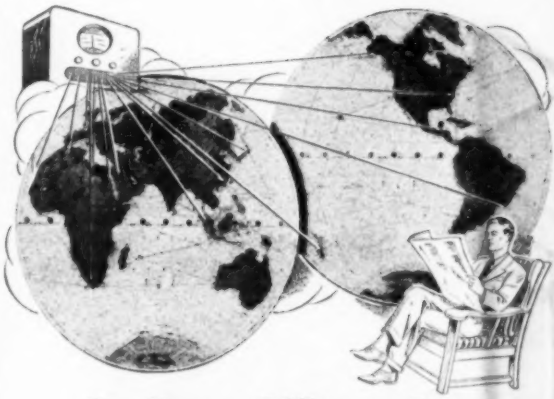

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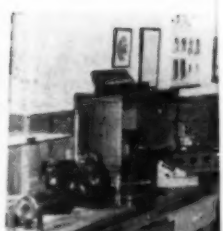

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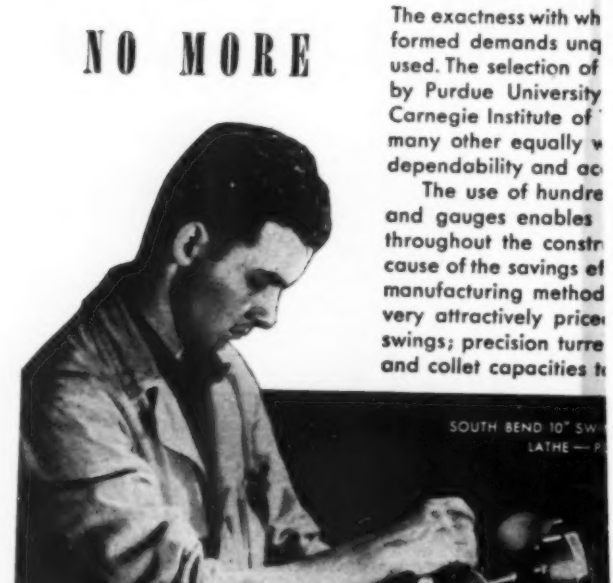

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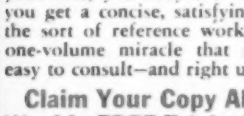

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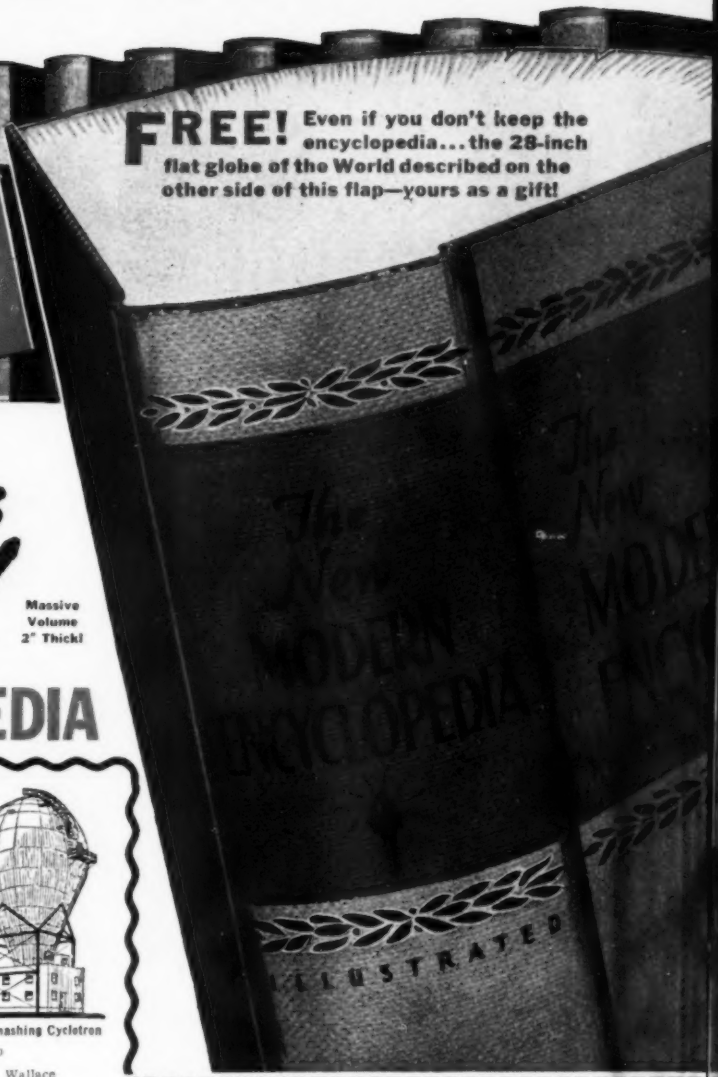

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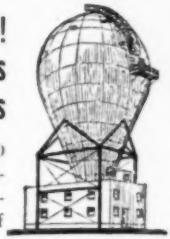

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